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The What's New magazine

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1982

PS tests the new generation of **convertibles**

MAKE YOUR CAR WHISPER QUIET INSIDE

10 hot new planes—and a $6450 kit motorglider that

flies all day on a gallon of gas

From Japan:
30% MORE-EFFICIENT CERAMIC DIESELS

PRO'S DOZEN
12 great tools you didn't know you needed

12
726597

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Popular Science MONTHLY®

The What's New magazine

DECEMBER 1982
Founded in 1872/Vol. 221, No.6

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A kit motorglider that flies all day on a gallon of gas
This $6,450 craft leads a pack of hot new fuel-efficient planes. PAGE 72

Three for the road: convertible comeback
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A pro's dozen—great tools you didn't know you needed
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COVER PHOTO BY DAVID A. GUSTAFSON

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PS READERS TALK BACK

Address letters for this column to: Readers Talk Back, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Because of the large volume of mail, we are unable to acknowledge unpublished letters.

The space retreat

"Did we do it right?" Chris Kraft asks in Jim Schefter's "It's Time to Stop the Space Retreat" [PS, Oct.]. My answer: Yes, the scientists, engineers, and technicians did it right. The politicians—presidents and members of Congress—did it wrong and betrayed our scientific progress. "Did we do it well?" No, we did it absolutely great—for as long as we did it.

The article closes with another question: "Which way will we tip?" For the sake of our survival, military and scientific, I believe we must continue to explore space. Without scientific progress, everything else is naught, zero, and zilch.

Al E. Erxleben, Tallahassee, Fla.

After President Reagan's July 4 speech, in which he skirted the issue of a space station, and before reading your fine article, I wrote to the president and to Vice President Bush to ask if the administration has any real plans for space habitation. I haven't heard from Mr. Reagan, but I got this rather hopeful reply from Mr. Bush:

"The United States does plan to continue a balanced program in space exploration, manned space flight, aeronautics, and applications, including the eventual goal of building a space station. The shuttle enhances the possibility of constructing a manned space station."

It seems to me that the Reagan administration is leaning toward a space station, but is unsure how popular it would be. I urge all POPULAR SCIENCE readers to write to the president asking for a go-ahead.

Ted Apelt, Miami, Fla.

Strange bedfellow

I found your article about the plastic automobile engine [PS, Sept.] very interesting and informative. I was amused, however, to see a GM Delco battery being used to power the Ford-backed research project.

William E. Reiner, Maywood, N.J.

Pulsed-furnace genesis

Having been director of research at the American Gas Association Laboratories during the period that the remarkable new pulse-combustion furnace [PS, Sept.] was developed, I noted several inaccuracies in your otherwise excellent article. Although pulse combustion was investigated at the Labs as far back as the early 1960's, work on the furnace itself did not start until early '74 and not "under a Gas Research Institute contract" but with the sponsorship of the Association's gas-utility-funded R&D program. By mid-'75 we had a hand-built prototype with the same performance as the new Lennox furnace. Moreover, it was within striking distance of being acceptably quiet: No one "had to wear earmuffs to tolerate the noise." Otherwise, Lennox would never have agreed, as it did in January 1977, to participate with us in developing a manufacturable prototype. Later that year, the Gas Research Institute took over active management of the project.

The thrust of our work with Lennox, which continued until the company made its go-ahead decision in September 1979, was further noise reduction. We also helped with development of a control package. This letter is not written to nit-pick, but to set the record straight. My fine team of former co-workers at the AGA Lab deserves much of the credit for the development of this gas-saving furnace.

Frank E. Belles, Bay Village, Ohio

As noted in the story, pulse-combustion boilers are not new. One such unit, called the Pulsamatic, was manufactured here in Winnipeg for a number of years in the early 1960's. My company continues to service 103 of these long-living boilers.

T. Scherpenisse
Active Mechanical Services
Winnipeg, Man.

Solar costs

Since entering the solar business in 1976, I have spent much of my time trying to debunk myths and misconceptions. Your article about the Hanson kit solar heater [PS, Sept.], which was labeled "low-cost" and "efficient," sounded like marketing hype from here.

A solar system with 19.5 sq. ft. of collector for $495 is very expensive—$25.38 per sq. ft. My company installs complete home-heating systems with collectors, air handler, rock storage, and DHW coil for less than $20 a sq. ft. Additional Hanson panels at $179 each—$18.34 a sq. ft.—is also high. And when the article cites a price tag of $495 compared with $2,000 for a conventional solar system, that's comparing systems of different sizes.

Also, some of the claims made for the collector's performance are beyond the laws of physics or belief. Hanson says that he improved heat output by a factor of five by making every sq. ft. of collector area heat five cu. ft. of air, allowing him to shrink the collector to one-fifth its original size. Nonsense and magic! There is only a certain amount of heat energy available from the sun in a given location. These Btu can be spread out by blowing a greater volume of air through a collector,

Continued

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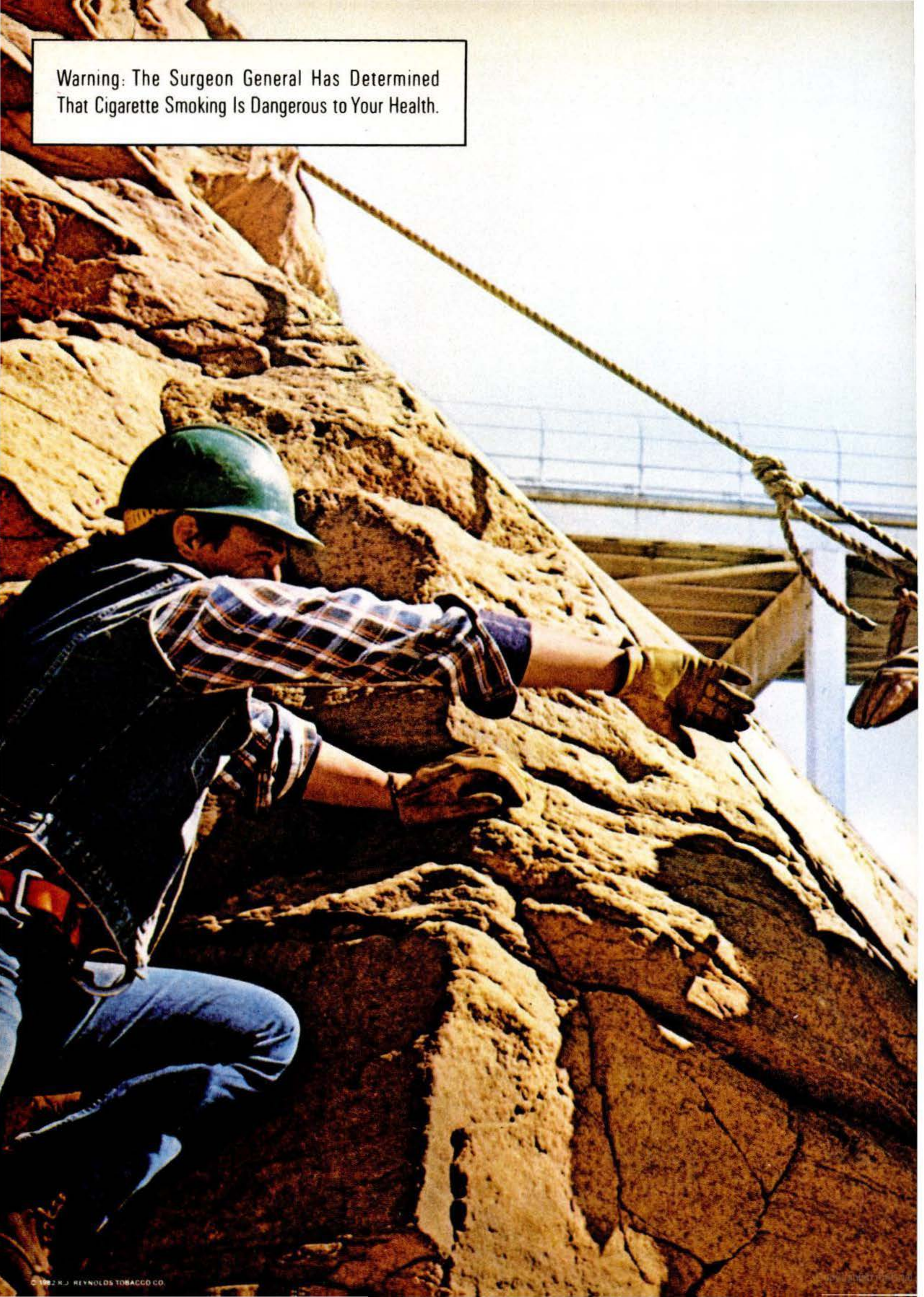
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HINT #12 FROM RCA VIDEODISCS

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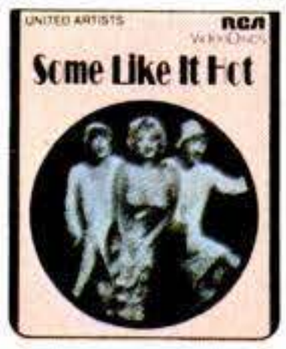
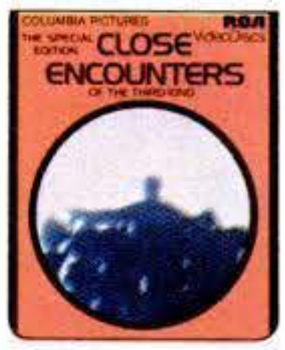
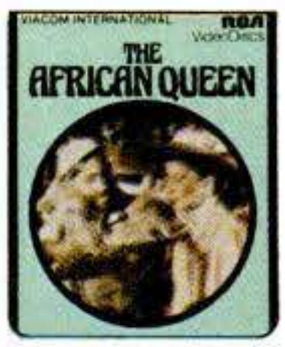
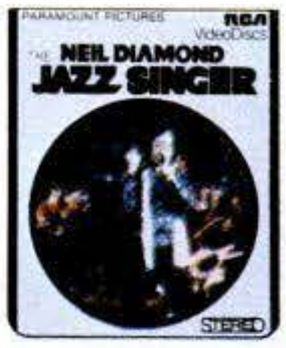
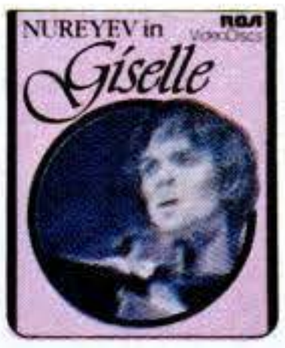




In fact, RCA VideoDiscs can keep you side by side on the loveseat for hours. Have a mini-honeymoon with *California Suite.* Get away from it all with *The African Queen.* Make beautiful music together with Neil Diamond in *The Jazz Singer.* Leap for joy over a ballet like *Giselle.*







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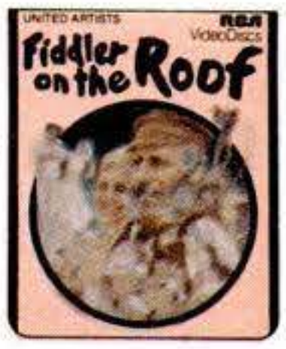

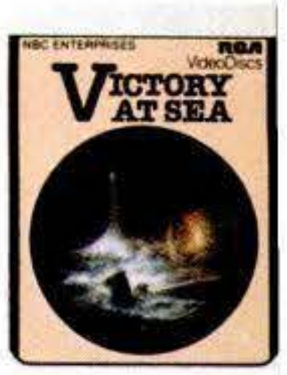

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[*Continued*]

which would marginally improve the efficiency, but it would certainly not improve performance by a factor of five.

Richard L. Pratt, President
Solar PIE, Columbus, N.C.

David Jack Hanson, manufacturer of the Hansolar TA-3 kit solar heater, replies: "Compared with similar units—ready-to-install collectors as opposed to ones the customer must assemble using some self-supplied materials—the TA-3 is low-cost. A recent listing of 'store-bought' air collectors in New Shelter *magazine included units ranging from $20 to $50 per sq. ft. A four-panel Hansolar system costs $22.70 per sq. ft. Even so, the cost-per-sq.-ft. approach for comparison of systems ignores the issue of initial cost. According to a 1980 Solar Energy Research Institute study, the average solar installation in 1980 cost $4,500. We submit that a $495 initial cost for a two-panel Hansolar system is low by comparison.*

"With regard to our performance claims, a careful reading of the POPULAR SCIENCE *article makes it clear that the five-times performance improvement refers to my original installation, not to solar collectors in general."*

Gone dotty

The illustration of a piezoelectric dot-matrix printer [PS, July] shows seven piezoelectric benders producing eight printed dots. Do I need new glasses?

Ernest H. Michaelsen, Hyannis, Mass.

No. We do.

Retooling for metric

While I agree that figuring all measurements in tenths, hundredths, and thousandths is much easier than in eighths, sixteenths, and thirty-secondths, I am one of the people really caught in the middle in converting to metric. I am a technician who has several thousand dollars invested in wrenches, drill bits, taps and dies, and measuring devices. I have spent more than 30 years collecting a complete set of these tools. There are millions of mechanics and technicians in the same boat as I am. My answer to the pro-metric crowd: Promote metric if you must, but be careful when you call for service on your metric equipment. I will use the tools I have and you may lose the corners off all your nuts and bolts.

Arthur Dobson, Buckley, Wash.

The transition to metric will not be as expensive as most people think. Certain tools and equipment we now have could still be used. For example, adding a 10-mm hex socket to a standard set of wrenches ranging from 7/32 in. to 7/16 in. enables you to handle all hex nuts and bolts between six and 10 mm.

Kenneth White, Port Charlotte, Fla.

If the editors of POPULAR SCIENCE cannot correctly convert Celsius to Fahrenheit ["Smart Missiles," PS, Oct.], what hope is there for the average U.S. citizen to make metric-to-English conversions correctly? The equivalent of −100 degrees C is −148 degrees F.

Harry G. Miller, Defiance, Ohio

Sub spotter?

The obvious next question to ask about synthetic-aperture radar's ability to scan ocean-floor contours [PS, Sept.]: Can it also detect the location of submarines on station? And was the budget cut the real reason for the "cancellation" of further work with SAR, or is the device already up there again as the "secret military cargo" aboard the last flight of Columbia? If so, you can be sure it's not summering over Nantucket's shoals.

Robert R. Bullard, South Daytona, Fla.

Frugalest flusher

As an architectural firm specializing in resource-conservation techniques, we have done an extensive review of the water-saving-toilet market ["Water Savers," "Frugal Flushers" section, PS, June]. The unit our research shows to be most impressive, the Superinse, manufactured by Thetford Corp. (Box 1285, Ann Arbor, Mich. 48106), wasn't listed in the article. This unit is totally passive (needs no electricity or compressor), uses just one gallon per flush, installs and operates conventionally, and is reasonably priced (about $550).

David Deppen
David Deppen Architects
Portland, Ore.

Chain lubes

After reading E. F. Lindsley's article on Teflon lubricants [PS, July], I immediately thought of motorcycle final-drive chains. What a way to beat the mess and bother of foam lubricants. Ability to withstand extreme pressure, protection against corrosion and rust, and an ability to last are what these chains need. Would someone on your staff please tackle the job of finding out if this usage is feasible?

Del Pierce
Schenectady, N.Y.

One of the products covered in the article, Super Lube, is particularly well suited for this application because its grease base prevents runoff.

Corrections: A wind machine we missed in "33 Windmills You Can Buy Now" is AXP 6000 by Hummingbird Windpower Corp. (13315 Stuebner Airline Rd., Suite 106, Houston, Tex. 77014). The upwind horizontal-axis machine has a direct-driven, three-phase, DC electric generator and is rated for continuous service at 6,000 watts in 26-mph winds. It is available in utility-tie-in or remote-independent versions.

The correct name of the publisher of *Energy Efficient Products and Systems* ["Alternate Energy Answers," PS, Nov.] is Energyworks, Inc. PS

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DETROIT REPORT

By JIM DUNNE

Volkswagen's 1,500-lb. mini-car, the Polo, may be made available in the U.S. in '84.

Rabbit reskinned

VW's Rabbit, now in its eighth year without a major styling change, is set for a complete reskinning in 1985. That puts it far short of the styling longevity record of the VW Beetle, which ran for almost 20 years in this country. The new Rabbit will be treated to an aerodynamic shape and some perking up of overall appearance. The present car is showing its age, and sales have sagged noticeably—so much so that VW may be planning to bring in a smaller mini-car, called the Polo, from Europe. [See PS cover story, June.] Polo would sell at a lower price than Rabbit and might help the American arm of the company through its current hard times. But according to a VW official, "It would take two years after the decision has been made to get the car into the U.S., and that decision has not yet been made."

The big get smaller

That's what GM plans for the C-body line—de Ville, 98, and Electra—in 1984. The new models will be completely redesigned with few, if any, carry-over parts from this year. What's coming? Start with front-wheel drive and V6 engines as standard. Add independent rear suspension, a four-speed automatic transmission, and a complete restyling job. Styling is the most dramatic change, making the big road kings look much like the A-cars, such as Chevrolet's Celebrity. Hood lines dive downward while trunk lids are perched high up in the rear. Naturally, the dimensions outside will be tighter by almost a foot in length and inches in width. But inside there will be plenty of room for five passengers, although six may sit more snugly than in the present models. Auto stylists, criticized for lack of imagination in creating the three-box look for most small cars, are going out on a limb with the new C-models. These cars will be highly unusual in appearance but are likely to set a new styling standard for full-size cars in the next decade.

Invest in silver—and black

If you could invest in black and silver paint, you'd be rich by the end of next year. That color combination is a dominant trend on '83 cars, inside and out. Most visible is the silver-and-black theme of many of GM's cars, especially Pontiac's 6000 STE and Buick's T-types, as well as the Hurst Olds Cutlass and Chrysler's 600/E Class. All feature silver bodies, with plenty of black trim. Special models from Ford and AMC have similar paint combinations. You see more of this theme under the hood. Two years ago Chrysler decided to use only silver and black for the engine compartment. This year Chevy quietly showed up at press previews with its line of engines wearing the same combination. "The customers like it; they believe it looks more European," a Chevy engineer explains.

Skirting the problem

GM officials sheepishly admit that the front fender skirts on a recently introduced idea car were "not very functional." While the skirts give a smooth surface to the wheel well, they also prevent the front wheels from steering. But there may be some solutions that will allow for the use of skirts. One is to bulge the skirts slightly outward; another is to attach the skirts to the axle, where they would turn when the wheel is turned and then return to a flush position when the car is traveling straight ahead.

Diesel doldrums

Ford insiders predict that recent gasoline-engine improvements present "a moving target" that is tough for diesels to sight and that these developments will keep diesels from a major share of the car market. Diesel penetration of the U.S. car market will rise more slowly than in the past two years because of lower gasoline prices and improvements in gas-engine efficiency through the 1980's—to a point where diesels will be used in only 10 to 15 percent of the cars by the end of the decade.

Bumper backpedal

That's the posture of the auto companies as they plan to go from five-mph bumpers to the recently allowed 2½-mph types. Some cars will get the change gradually; some may not get a major change at all. Olds will go to 2½-mph bumper types over time and save 15 pounds in its biggest bumpers. How much of a saving will that mean to the customer? No answer, or "something like $15," is the best you will hear. One problem with changing back to the lower-speed protection: Bumpers are systems now, not just metal bars. Supports extend back under the sheet metal, and a change in one place could upset the entire system. A complete redesign is the best method of change, and that takes time.

Cards instead of keys

A long look ahead at what auto engineers are working on reveals this item: a key card that will unlock your car, start it up, and make it comfortable for you. Buick's chief engineer Ed Mertz says the card will be inserted in a slot in the door, just like many security locks in commercial buildings. But in addition to taking the place of a key, the card will activate motors that will set your mirror, adjust your seat and steering wheel, and start the motor at the same time. Electronics is the key, says Mertz.

Chrysler will have diesels

A four-cylinder diesel for passenger cars and small trucks, and a six for bigger trucks, will be made out of the company's 2.2-liter and 3.7-liter (134.3 and 225.8 cu. in.) gasoline engines. Both will have turbochargers to make up for the horsepower loss of the diesel cycle. Chrysler will be building the engine in cooperation with Perkins Diesel, which means that some will be sold to engine buyers in the construction- and marine-equipment businesses. Look for the first Chrysler 2.2 diesel in late 1984, just in time for the 1985 models. PS

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HOTTEST NEWS I
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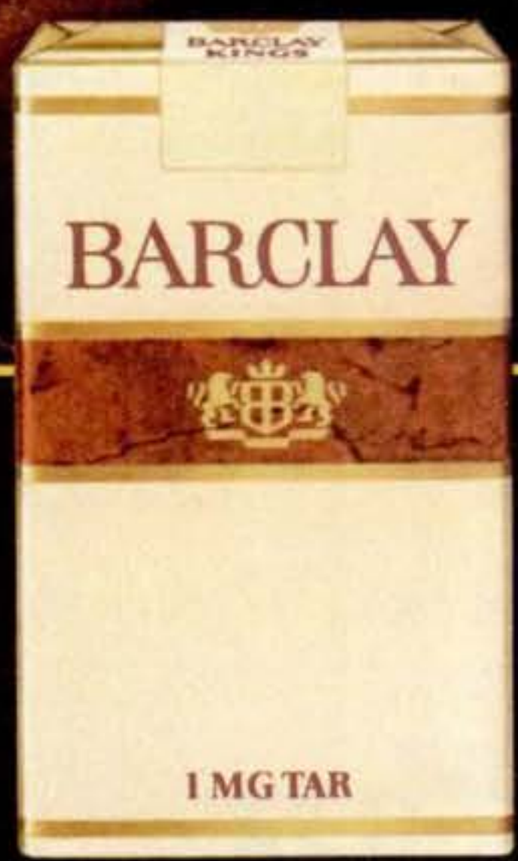

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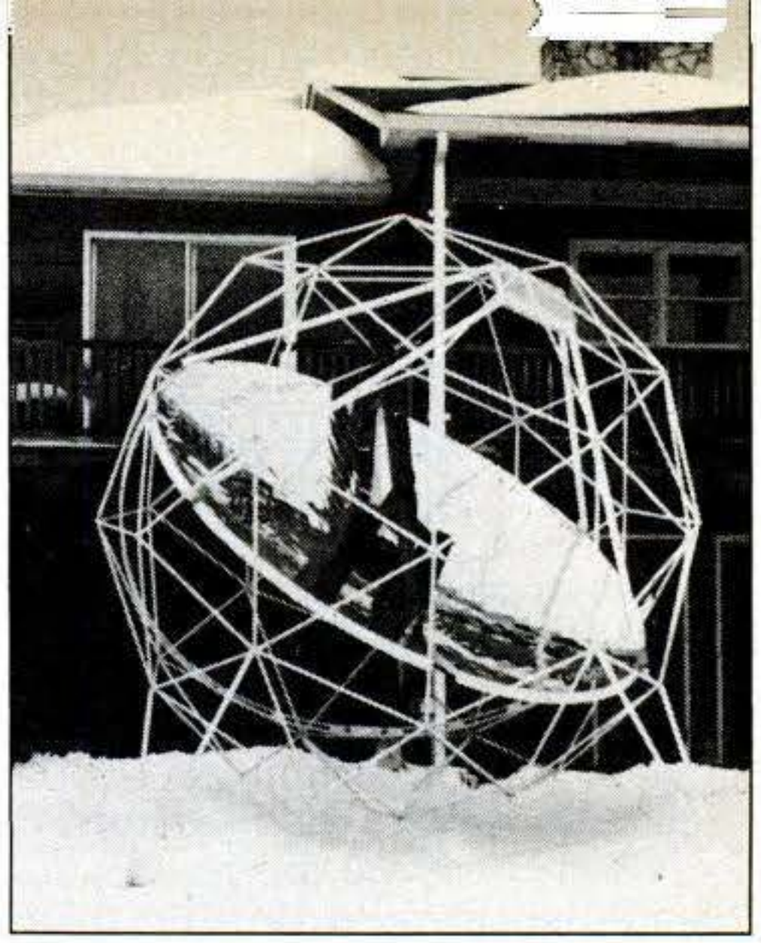
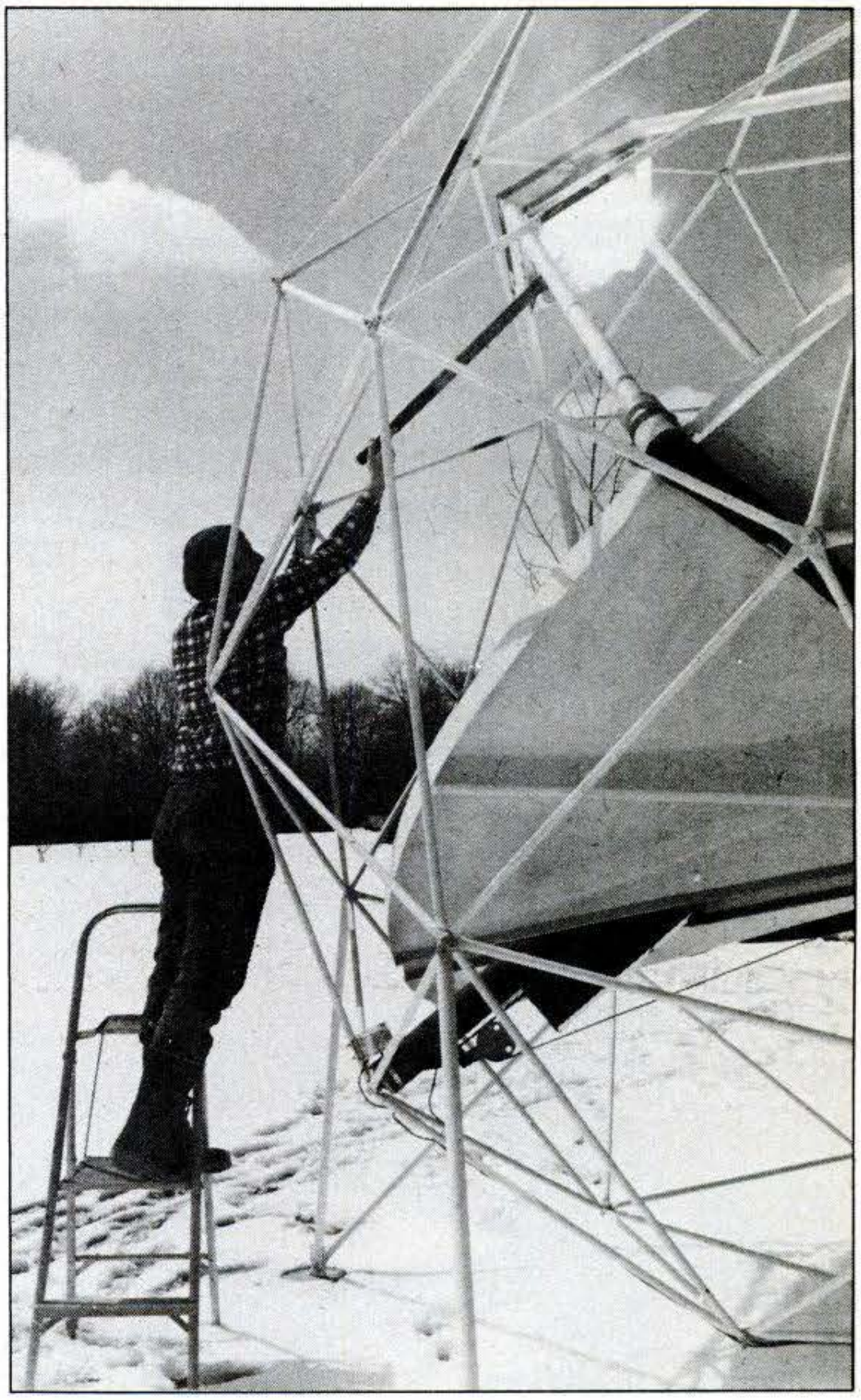


Low-cost, high-efficiency geodesic solar concentrator

Electrical conduit gives rigid support to this focusing, tracking collector

By JAMES A. BAGGETT



Jerry Smyth stood a few yards from his spherical solar collector and tossed a tightly packed snowball toward the steel-plate receiver at its apex. Instantly, it flashed into steam.

His unit, dubbed the Interceptor, uses two-axis tracking to position a parabolic reflector to concentrate the sun on the receiver from dawn to dusk. When not boiling snowballs, the collector at Smyth's home in Huntington, Ind., preheats domestic water and assists space heating. "Last winter, when the temperature was −15 degrees F and the chill factor was 60 below, we were producing a gallon a minute of 165-degree water," the inventor said.

Everyone knows that concentrators put out high temperatures, but most focusing collectors are complicated, high-cost items. Smyth's collector, using only readily available and easy-to-assemble materials, has a cost per Btu that compares favorably with any commercial solar or conventional energy system.

The device looks more like a mini-Astrodome than a solar collector. The parabolic reflector sits inside a 20-sided geodesic framework of electrical conduit arranged in triangular patterns—a simple mounting that provides great strength and rigidity. The near-sphere is bolted to the ground by three leg supports. It can be erected anywhere on the Earth's surface without needing custom mounts for its tracking function; the polar axis must simply be rolled around until it points north-south.

The reflector consists of over 900 plain-glass mirrors bonded to six structural fiberglass panels joined to form the parabolic shape. Smyth chose plain glass after testing a variety of reflective surfaces because it produced the most Btu for the least cost. With 90 square feet of reflective surface, the device has a concentration ratio of about 900 suns. That's significant because it overcomes the notorious inefficiency in other than clear-sky conditions of common solar concentrators with lower concentration ratios. "An energy gain is realized as long as there are detectable shadows on the ground," said Smyth.

The reflector is driven by a 1/100-hp tracking motor guided by a control box that keeps the mirrors aimed just behind the true position of the sun when the sun isn't shining. When it reappears, phototransistors detect the position error, start the motor, and make the correction. At sundown, the mirror returns to the sunrise position.

Under clear-sky conditions, the collector delivers up to 15,000 Btu per hour. Depending on working temperature, governed by the flow rate of cooling fluid through the receiver, the collector ranges from 50 to 80 percent efficient—a big jump from the 40 to 60 percent efficiency of the best flat-plate collectors.

Such numbers have encouraged Smyth to look beyond residential application for his collectors. Industrial uses could include distillation, pumping water, and generating electricity. "We already have a unit installed in a New Hampshire maple-syrup plant," Smyth said. PS

This patented system is available for licensing. For details: Smyth Aerodynamics, Box 308, Huntington, Ind. 46750.

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Blips from the underground: earth-probing radar

A team of archaeologists mapped out a subsurface prehistoric Indian village in Ohio without breaking ground. A survey crew in New York located buried containers of toxic chemicals before excavating. And mining engineers in many states have "seen" into subterranean rock to identify hazardous formations.

Superman's X-ray vision? No, XADAR's ground-probing radar. In each case, transmitting radio waves into the earth resulted in big savings of time, money, and—potentially—lives. The technique's high-resolution, instant readouts and nondestructive nature have proved so useful that the Springfield, Va., based XADAR Corp. is now developing custom units to match specific exploration and construction applications. The company also performs radar surveys at customer field locations.

The basic unit includes a pair of antennas contained in a metal box that is moved along a surface. A transmitter emits a radio signal that travels through the earth until it strikes a material with different electrical properties from the surrounding material. A portion of the signal is then reflected back to the receiving antenna. The reflections are processed in a microcomputer, and a profile of underground features is displayed on a screen and recorded on a strip chart.

The depth of the signal's penetration depends on the material, says XADAR Vice-President James Fowler. "It varies from a few feet in shales to over 50 feet in coal to hundreds of feet in granite." The company is working to extend the range through coal to 300 feet or more. Coal-mine safety regulations require that core-hole drillings be taken at regular intervals so that the electrical, chemical, and structural properties of the ground ahead can be determined. The company expects that radar profiles will prove to be at least as accurate in identifying water- or gas-filled cavities and in determining the structural integrity of mines.—*Daniel Ruby*

Underground surprises can be deadly to miners. Ground-probing radar spots faults and abandoned shafts that could lead to flooding, gas release, or collapse.

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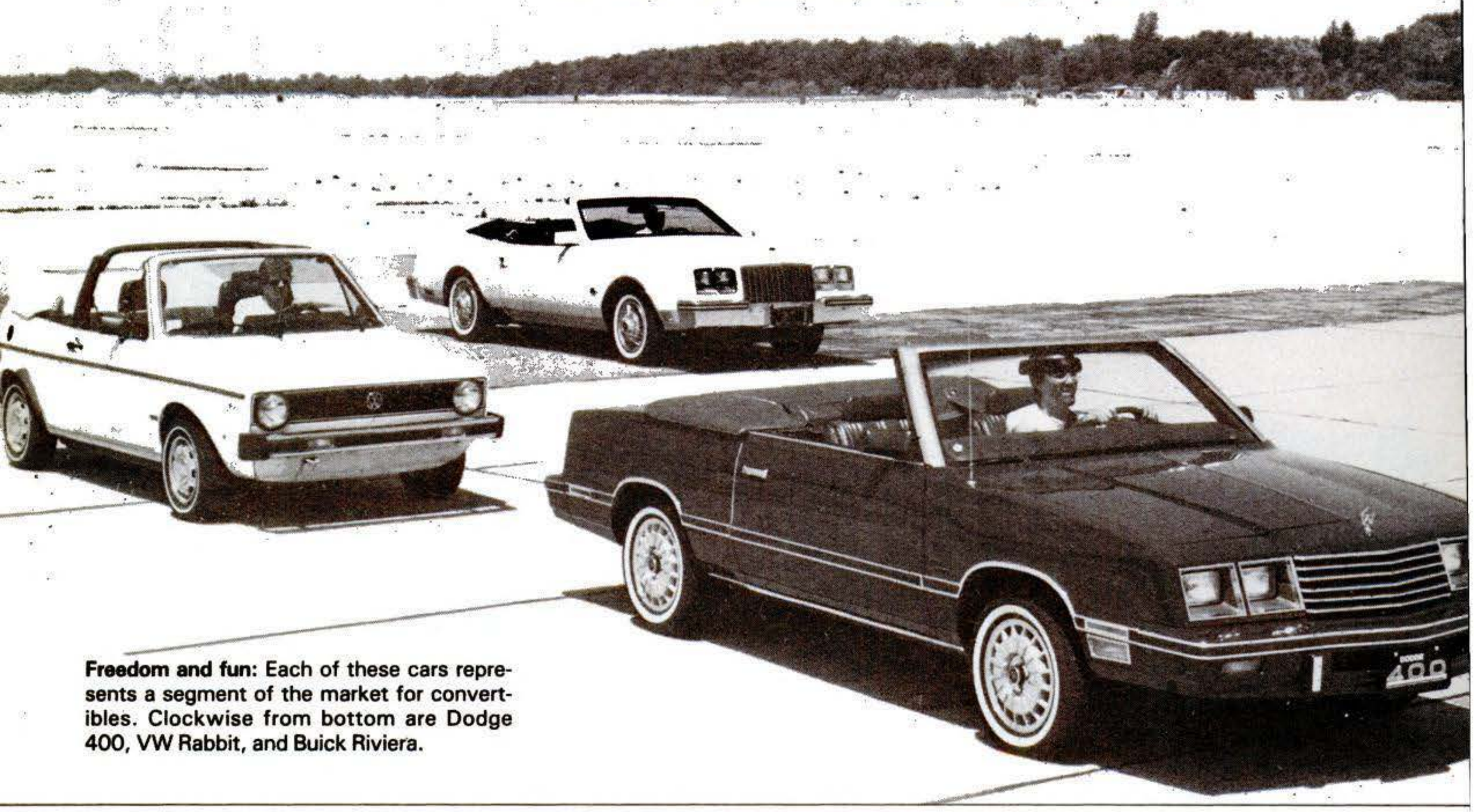
Three for the open road: convertible comeback



Freedom and fun: Each of these cars represents a segment of the market for convertibles. Clockwise from bottom are Dodge 400, VW Rabbit, and Buick Riviera.

By JIM DUNNE and JACK KEEBLER
PHOTOGRAPHS BY GREG SHARKO

Tired of riding in an air-conditioned, noise-proof sedan that has all the excitement of an evening in the living room and none of the adventure of the open road? If so, you're not alone. Auto companies are betting that car buyers will take renewed interest in the convertible.

Since 1976, when Cadillac stopped making the convertible Eldorado, no American company has produced convertibles as part of its regular lineup. But Chrysler, Ford, and General Motors are back in the convertible swing.

We gathered three markedly different examples of the convertible renaissance: Buick's country-club-posh Riviera; Dodge's tight, compact 400; and Volkswagen's Rabbit convertible, which made its debut in 1980. (Not available in time for our test were Ford's chop-top Mustang [PS, Oct.], due out about the time you read this, and GM's Pontiac 2000 and Chevrolet Cavalier J-cars, which will be available as convertibles in 1983.)

We put the soft-top trio through our regular test routine, checking acceleration, braking, noise levels, handling, and fuel economy. We also took a close look at the special problems and rewards that go with convertible driving. We found that convertibles provide a special kind of motoring enjoyment that's been missing for too long. But there are drawbacks, too, not to be ignored.

In the regular PS road tests, the convertibles performed much the same as their sedan counterparts—with a couple of important exceptions. Acceleration is on a par with that of regular sedans, though none of the cars was sensational. Braking results are similar, too. Handling is a dash less refined, thanks to a heavier chassis and slightly different weight distribution. But the ride is equal to that in a conventional sedan.

The real difference is in interior noise levels. Even with the top up, decibel readings are about four points above those of sedans, which rarely exceed the mid-70's (see comparison table). (A change of three or more decibels is considered significant by sound engineers.) With the top down, road

PS ratings— test report in a nutshell

The ratings are based on test results and measurements. Results should be read with the understanding that they reflect tests only on our sample cars. An excellent rating is 5 points; very good, 4; good, 3; fair, 2; poor, 1; very poor, 0.

	Buick Riviera	Dodge 400	VW Rabbit
Acceleration	3	4	3
Braking	2	2	2
Handling	2	2	3
Maneuverability	4	4	5
Quietness	3	0	0
Roominess	3	3	2
Vision	1	2	3
Entry/exit ease	4	3	3
EPA economy	2	4	4
Ride comfort*	5	3	2

*Authors' opinion

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noises take a lot of the joy out of freeway driving. We found that cruising in normal freeway traffic produces decibel readings in the 80's, while passing a diesel tractor-trailer pushes readings into the 90's. At speeds above 50 mph, the quality of the sound that reaches your ear from the radio is very poor, and normal conversation is nearly impossible.

You get some relief by leaving the windows up and by raising the roof, but the fabric top simply can't match the sound insulation of a metal roof. And when you invite the open road into the passenger compartment, you also invite road dust. All of the PS road testers felt the need for a shower after long trips.

Can these problems be ignored when weighed against the fun of topless driving? Yes! On the right day, a convertible can create a golden memory. Pick a two-lane on a sunny afternoon with a light breeze, and you'll enjoy the sensational experience of open-air motoring.

Golden memories aside, raising or lowering a convertible top is not a one-step operation, despite what you've seen in advertisements. To open the powered tops on the Riviera and 400, you first pull two releases on the windshield header, then raise the top a few inches to relieve the pressure on the rear-window zipper. Next, climb back into the rear seat, unzip the window on three sides, and swing it down into the boot. Then push the power button to open the top the rest of the way. Finally, you install the boot cover, the plastic lid that gives the convertible's rear deck its trim, finished look. Both powered tops are raised and lowered by a pair of hydraulic cylinders. Hydraulic pressure is supplied by a small, electrically driven pump located behind the rear seat.

Volkswagen's manually operated top is not as much bother as you might think. You go through the same opening and closing steps as with the powered tops, using some muscle only when swinging the top up and down. Indeed, despite its lack of power assist, the VW top may be the easiest to stow and put up. A little push is all that's needed to move the top back into the boot.

On models with a pliable plastic rear window, such as the Dodge 400, you must be careful to drop the window into the boot and *not* leave it zipped to the roof when lowering. Otherwise, it will kink permanently, greatly reducing rear vision. Riviera

Continued

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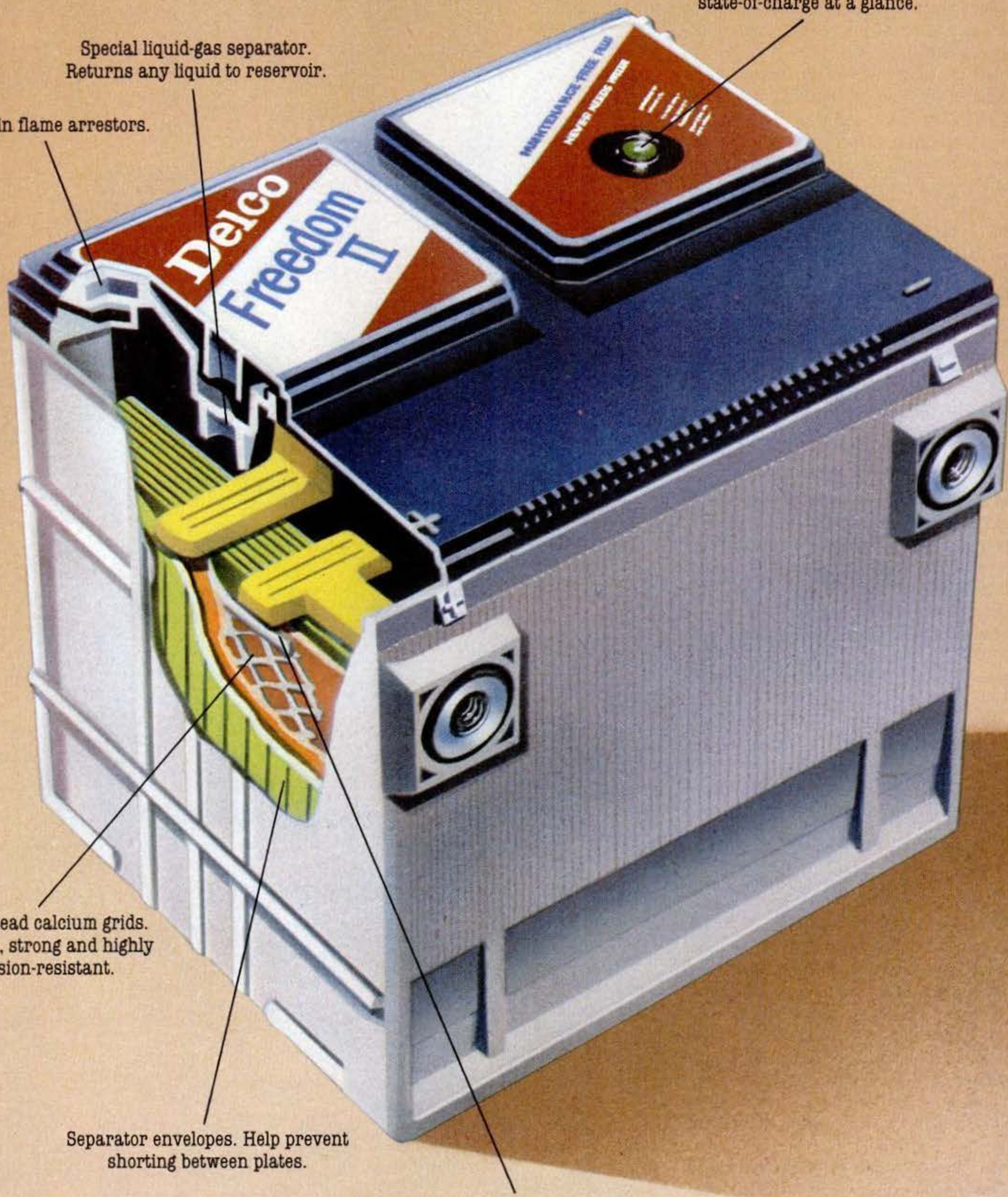

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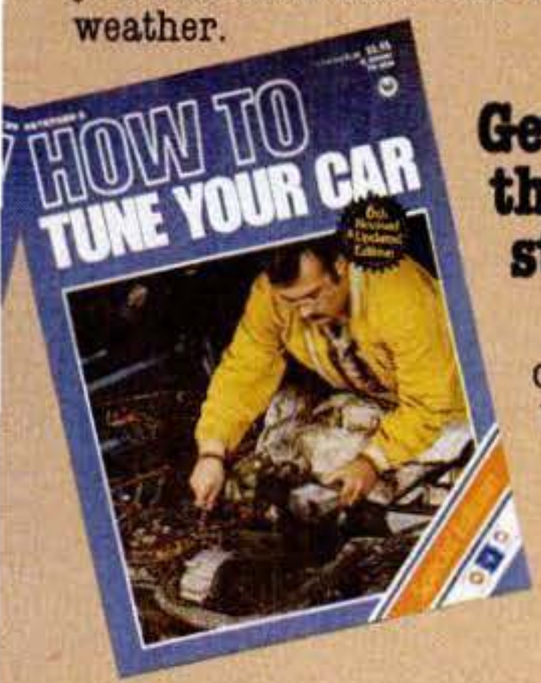

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Dodge 400 locks up its rear drums despite efforts at pedal modulation. Its stopping distance was worst cold, best hot.

Aggressive maneuvers and rough roads revealed body flex in Riviera, yet the car handled well for its weight and size.

and Rabbit both have a glass backlite, which will not score when scraped clean of frost and will keep its shape for the life of the car. The VW backlite also comes with a heater for frost removal.

Each of the cars has extra stiffeners in its body. They add 42 pounds to the Dodge, 174 pounds to the Buick, and a whopping 379 pounds to the Rabbit. Heavy-gauge-steel parts are used in the undercarriage, the door-lock post, and rear quarter-panel areas. Dodge has a large box-shaped torque tube running lengthwise along the floor, similar to the drive-shaft tunnel on rear-drive cars.

Strangely, the VW and Dodge unit bodies are as taut as sedans on most road surfaces. However, the Riviera, the only car with a conventional frame, seemed to show the greatest amount of body flex on rough roads. This is surprising because the unit-body cars should have suffered a greater loss in structural integrity through the removal of their tops. Perhaps this only underlines how good a job Chrysler and Karmann have done.

All three convertibles carry hefty price tags, so be prepared for sticker shock that may change your mind about flashy transportation.

Here's how they look in detail:

Rabbit convertibles give up their hatch, but a usable mini-trunk below the convertible top is handy for small suitcases.

Buick Riviera

At $24,000, this luxury carriage has by far the highest price. Its 252-cu.-in. V6 engine is well-muscled for the chassis, though the car is no top performer. Leather seats are standard, and they are a nice touch that fits in perfectly with this car's custom look.

The Riviera convertible's blind spot at the sail panels is even larger than on the hardtop sedan; it's a real problem, especially when backing with the top up.

In its raised position, the top looks neat, with no sags. In fact, its appearance is so tidy that the Riviera appears to have a cloth top over a steel roof, and was often mistaken for one of the imitation convertibles.

Dodge 400

The 400 seems to be the best size for all-around use. Although its dimensions more closely approximate those of a two-seater, the neat little mini-seat in the rear comes in handy when extra passengers need a lift for short trips.

Its engine is the Mitsubishi-built 2.6-liter (156 cu. in.) four, featuring twin counter-rotating vibration-damping shafts. The engine is husky and quiet, though no screamer in performance. Overall, when you add fuel economy, the engine is just right for a car this size. It's even strong enough to handle that most decadent of convertible options: air conditioning.

VW Rabbit

This made-in-Germany version of the popular Rabbit has a special body constructed by coach-builder Karmann. We found that the convertible duplicates the base Rabbit sedan in braking and maneuvering tests. Performance is acceptable, even though our test car was hampered by a slipping clutch. (This is the third time that a VW product has shown up at a car test with a soft clutch, which leads us to conclude that there may be an inherent weakness there.)

The padded metal bar that curves over the top of the Rabbit chassis is highly functional. VW claims that it acts as a frame stiffener, as well as a roll bar. For us it came in handy as a brace for passengers who needed to stand up in a moving car—not recommended, but useful for photographers, parade queens, and politicians.

EPA fuel mileage (mpg)

	Buick Riviera	Dodge 400	VW Rabbit
Highway	29	31	40
City	17	23	27
Calif. city	17	21	28

PS fuel-mileage tests
(steady-state mpg)

35 mph	32.2	32.3	30.0
55 mph	20.4	23.9	26.7

Our picks

Like a kid in a candy store, I'd like to have all three in my garage. Pin me down, though, and the Dodge 400 gets the nod. Somehow it's an improvement on the K sedans as far as driving feel and ride are measured, and it has the right size and flair for my sporty tastes.—J. D.

Although it drew crowds, the Buick's price is outrageous. The Dodge was well engineered and put together, but I couldn't get excited about its boxy, K-car styling. Rabbit was my favorite. It's simple, more affordable, and has to have one of the best fully lined and padded folding tops at any price. —J. K.

For specs and test results, turn page

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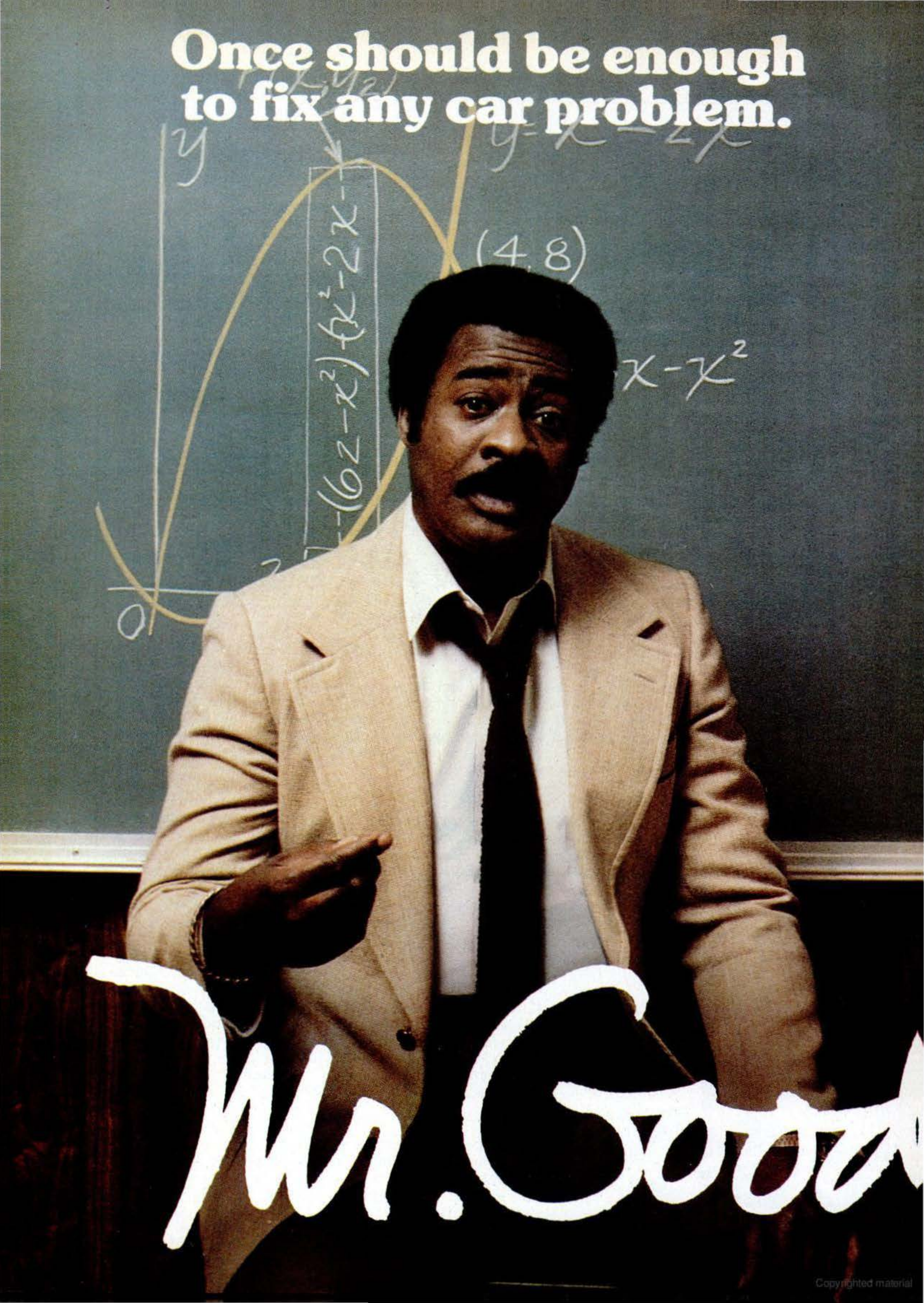
Once should be enough to fix any car problem.



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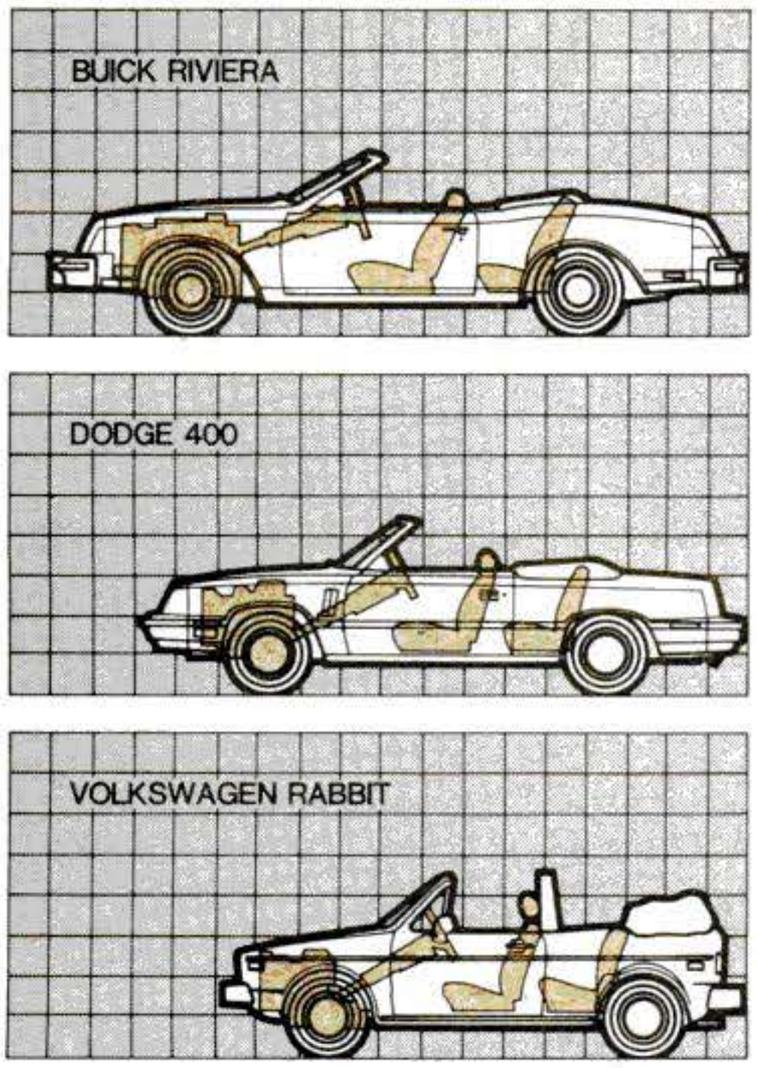

ILLUSTRATIONS BY RUSSELL VON SAUERS

Open-air touring requires a top that flops, but even within this theme we can see a great deal of diversity. Buick Riviera (top) is a curvaceous classic, while Dodge 400 (center) and VW Rabbit offer a flat, clean shape that is more contemporary. All of the cars lost some load space, or passenger room, or both, to the folding top's stowage area and mechanism.

PS serviceability ratings

How easy is it to service our test cars? For example, is that heater hose clamp out in the open where it can be reached easily? To give you an approximation of how difficult it is for a typical person to perform various service operations on the cars, we examine each vehicle. Here's what the numbers mean: 1, very difficult; 2, difficult; 3, average degree of difficulty, no worse or better than most other cars; 4, easy; 5, very easy.

	Buick Riviera	Dodge 400	VW Rabbit
Checking fluid levels			
Battery	5	5	5
Master cylinder	5	5	3
Windshield washer	4	5	5
Engine oil	3	5	5
Coolant	4	4	5
Checking the engine			
Spark plugs	3	4	5
Distributor	4	4	5
Carb adjustment	*	*	F.I.
Oil filter	4	4	4
Oil fill	3	5	5
Replacing hoses			
Upper radiator hose	4	5	5
Lower radiator hose	4	3	4
Heater hoses	3	4	3
Changing bulbs			
Headlights	4	4	4
Taillights	3	5	5
Front running lights	4	5	3
Front parking lights	4	5	3
Front directionals	4	5	3
Rear directionals	3	5	5
Rear running lights	4	5	3
Checking fuses	3	4	5
Spare-tire accessibility	3	4	4
Changing belts	3	2	4

*Sealed

Performance comparison with selected 1982 and earlier models

	Mpg (city driving)	Acceleration 0–60 mph (sec.)	Brakes 60–0 mph (hot) (ft.)	Handling (mph)	Maneuverability (mph)	Noise @ 60 mph (dBA)
1979 Buick Riviera V6	16	14.1	140	62.4	28.1	63
1980 VW Rabbit 4	30	13.0	160	63.7	29.6	74
1981 Chevrolet Monte Carlo V6 turbo	19	13.3	186	64	27.6	72
1981 Dodge Aries 4	24	18.1	175	63.5	27.6	71
1981 Ford Thunderbird 6	18	23	193	59	26.4	72
1982 Dodge Charger 2.2 4	25	11.7	178	65	27.6	75
1982 Pontiac J2000 4	25	18.9	193	62.2	27.6	71
1982 VW Scirocco 4	28	14	150	62.5	27.1	70

Buick Riviera, Dodge 400, and Volkswagen Rabbit—dimensions, specs, and test results

	Buick Riviera	Dodge 400	Volkswagen Rabbit
DIMENSIONS (inches)			
Wheelbase	114	100.1	94.5
Overall length	206.6	179.6	155.3
Overall height	54.3	54.1	55.5
Overall width	70.4	68.5	63.4
Track, F/R	59.3/60	57.6/57	54.7/53.1
Ground clearance	5.11	4.1	6.5
Front head room	39.4	37.7	36
Front hip room	53.7	46	44
Front leg room	42.9	43	43
Rear head room	38.5	35.2	36.4
Rear hip room	44.5	45	45
Rear leg room (min.)	35.6	30.5	29.5
Rear knee room (min.)	30	2.9	25
Couple distance	2	30	1
SPECIFICATIONS			
Engine type	V6	In-line 4	In-line 4
Displacement (cu. in./L)	252/4.1	156/2.6	89.7/1.5
Compression ratio	8.0:1	8.2:1	8.2:1
Carburetion	4-bbl.	2-bbl.	F.I.
Net hp @ rpm	125 @ 4,000	93 @ 4,500	76 @ 5,500
Net torque @ rpm	205 @ 2,000	132 @ 2,500	83 @ 3,200
Transmission	4-speed automatic	3-speed automatic	5-speed manual
Axle ratio	3.15:1	2.78:1	4.17:1
Tire make	Uniroyal	Goodyear	Continental
Tire type	All-Season Radial Steeler	Arriva Radial	TS Radial
Tire size	205/75R15	185/70R14	175/70SP13
Steering	Power, recirculating ball	Power, rack and pinion	Manual, rack and pinion
Overall steering ratio	14:1	18.3:1	20.8:1
Turns, lock to lock	3.0	3.2	3.8
Turn diameter (ft.)	39.2	34.8	34.3
Front suspension	Independent, torsion bars on lower control arms	Independent, MacPherson struts, coil springs	Independent, MacPherson struts, coil springs
Rear suspension	Semi-independent, coil springs on control arms	Independent, trailing arms, flex beams, coil springs	Independent, torsion-beam axle with trailing arms, struts, coil springs
Front stabilizer-bar diameter (in.)	1.09	1.0	n.a.
Rear stabilizer-bar diameter (in.)	0.86	1.0	n.a.
Trailer towing (max. lbs.)	1,000	1,400	1,000
Trailer tongue weight (max. lbs.)	100	150	100
Brakes	Disc/disc	Disc/drum	Disc/drum
Brake swept area (sq. in.)	307.6	260.57	n.a.
Fuel tank (gal.)	20	13.0	10.6
Trunk space (cu. ft.)	12.7	13.1	6.0
Liftover height (in.)	27	30	19
Curb weight (lbs.)	3,864	2,592	2,204
F/R weight distribution (%)	59/41	65/35	63/37
Basic price	$23,983*	$12,600	$10,595
Price as tested	$26,319*	$15,197	$11,880
Major options on test car (over $100)	Power seat $197, electric recliner $139, climate control $150, oversize tires $104, theft deterrent $159, stereo w/cassette $242	A/C $676, 2.6-liter engine $171, speed control $155, power windows $165, power locks $106, AM/FM stereo tape $455, tilt wheel $155, road wheels $319	A/C $690, sport seats $195, alloy wheels $350
TEST RESULTS			
Acceleration (sec.) 0–60 mph	16.8	15.2	17
Brake test (cool) 60–0 mph Stopping distance (ft.)	177	194	167
Pedal pressure (lbs.)	100	140	45
Brake test (hot) 60–0 mph Stopping distance (ft.)	186	182	187
Pedal pressure (lbs.)	60	155	45
Interior noise @ 60 mph (dBA)†	69	72	76
Handling test (mph)	58.4	57	61
Maneuverability test (mph)	27.4	27.3	28.8

TEST CONDITIONS: Ambient temperature, 82°F; relative humidity, 80 percent; barometric pressure, 30.01 inches Hg
*1982 prices
†Top up

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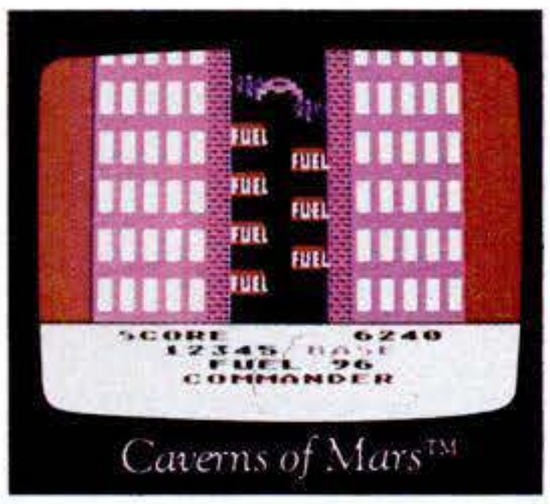

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†EPA ratings not applicable. Based on Ford tests simulating on-road driving conditions. Improvement over gas engines varies depending on use.

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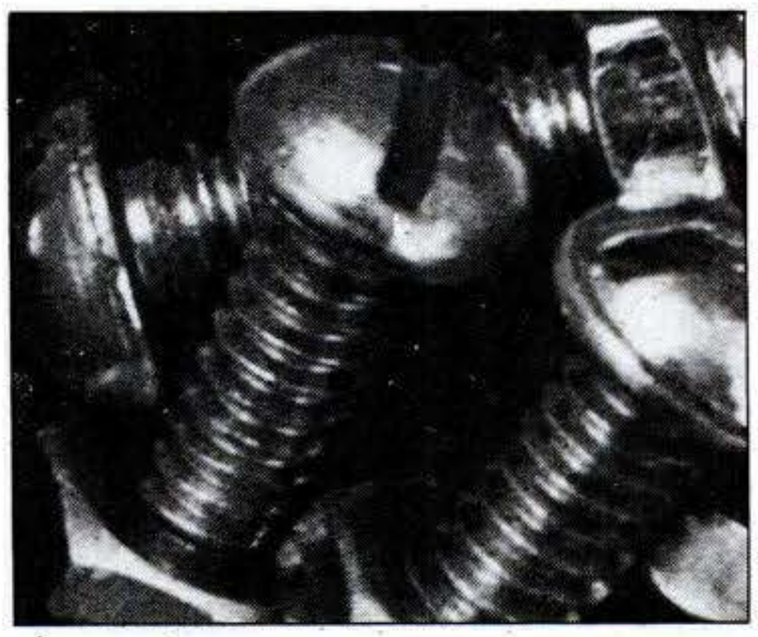
THROUGH THE VIEWFINDER

By EVERETT H. ORTNER



The unforgiving film

Strange things can happen, even in so well-ordered a company as Eastman Kodak. Which explains why a fine-grain, high-contrast, black-and-white film, whose predecessors were used to capture solar flares or to record images lighted by lasers, has turned out to be a magnificent variable-contrast film capable of producing portraits and still-life studies.

It's said that technicians in solar labs using Kodak's SO-392 or photomicrographers using Kodak's SO-410 (the same film) were taken with the extraordinary resolution and virtual grainlessness of their films and said to themselves, "Hmmm . . . suppose I developed this high-contrast film in a low-contrast compensating developer, what would I get?" What they got was a film system of startling versatility, capable at once of scientific work of the utmost precision and pictorial work of extreme tonal gradation.

Now the earlier films have been replaced by Kodak Technical Pan Film 2415, which has just been made available in 36-exposure 35-mm cartridges. And Kodak, its eyes finally opened to new possibilities, has brought out a developer that makes available to all photographers the full capabilities of the film. It is sold as Technidol LC (for low-contrast), and comes in packets designed to make one-shot solutions—one packet to two film cartridges. In fact, you can buy it just that way: Kodak's Tech Pack 2 contains two cartridges of 2415 film and a Technidol LC packet. It lists for $8.50. You can, of course, still use 2415 as a high-contrast film—just use a different developer. The film, separately, is $3.50. Three Technidol LC packets are also $3.50.

Why is 2415 an unforgiving film? Because it shows up all the flaws in your system: the fine, normally invisible scratches that you put on the film when you squeegeed it (*never* squeegee 2415!), unsharp lenses, slightly unsharp focus, and, in great enlargements, fringe unsharpnesses—as points in the "circle of confusion" at the edge of a lens's depth of field are enlarged. The film's 400-line-per-mm resolution exceeds the resolving power of most camera lenses.

Kodak likens an eight-by-10 print made from a 2415 35-mm negative to one made from a four-by-five neg. The pictures above bear out the claim. The left eye of the model (above left) is shown enlarged 50 times at top right. The 50× enlargement—equivalent to a four-by-six-ft. print from a 35-mm frame—shows spectacular detail. Below the eye is a 50× enlargement of a tiny bit of a 35-mm picture of a box of nuts and bolts. Great stuff!

600-system SLR

The optics and quality of the folding autofocus SX-70 camera, with its single-lens-reflex viewing, and the advanced electronics and ASA 600 film speed of Polar-

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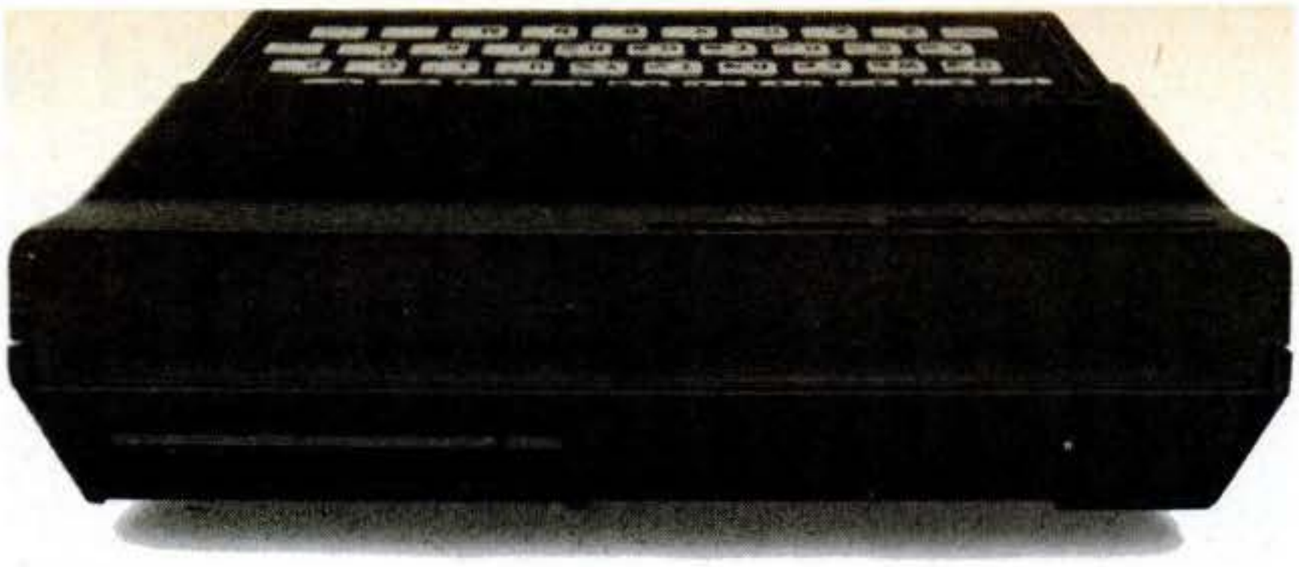

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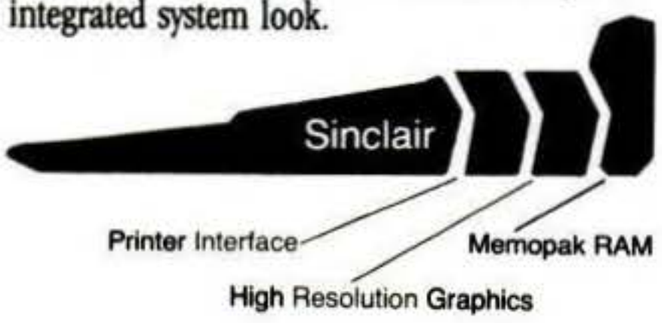

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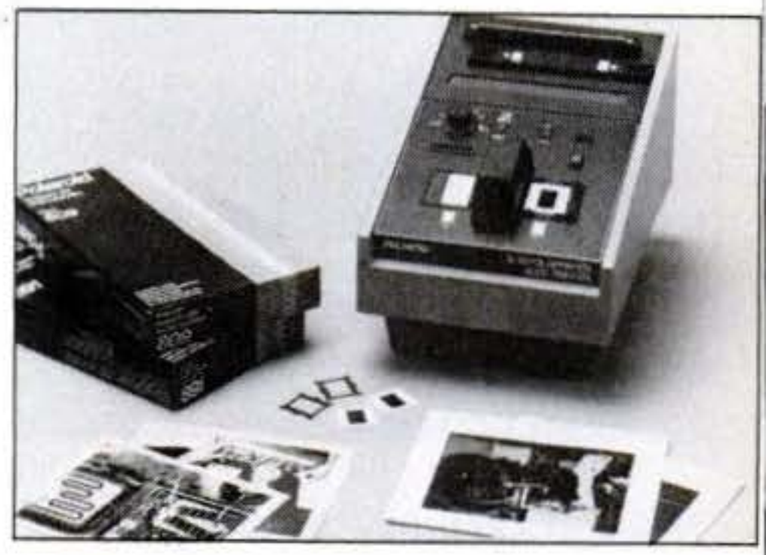
oid's 600 system [PS, Sept. '81] have now been brought together in a new camera, the Polaroid SLR 680 (photo above). The 680's built-in flash is linked to both the camera's autofocus system and its autoexposure system. The autofocus system focuses both the lens and the flash, causing the latter to adjust its angle (up to 10 degrees) to correspond to subject distance.

The camera's sophisticated exposure system tells the flash how much light to put out: *fill* flash to soften contrasts in bright outdoor scenes or *full* direct flash



in low-light situations. The flash charges in as little as three seconds, at the touch of the shutter button. Exposure is via a four-element glass lens with apertures from f/8 to f/90 (!) and shutter speeds from 1/180 to 14 seconds. List price: $265. Picture quality: first class.

For really big instant pictures, look to another new Polaroid device: the 8×10 Polaprinter (above). It converts 35-mm slides to either eight-by-10 color prints or transparencies for overhead projection. Price: not set as of this writing.

Single-dip color

Expose a sheet of Agfachrome Speed paper in your enlarger (through the back), then swish it through a tray of Agfachrome Speed activator for 90 seconds. Now turn on the lights and wash the print for a minute. As you watch, colors appear—first pastel, then brilliant. Three more minutes of washing completes the process.

That's Agfa-Gevaert's claim for its Agfachrome Speed system, scheduled for introduction this fall. The one-sheet, one-solution process gives "professional quality in all formats," Agfa claims. Moreover, "since the contrast can be varied, you achieve high-quality results even from originals too high or low in contrast." I'll certainly be checking out those claims. PS

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SCIENCE NEWSFRONT

By ARTHUR FISHER

Giant wind tunnel

The world's biggest wind tunnel is getting even bigger. Shown in the photo below is the enormous air intake for a new section being added to the existing tunnel at NASA's Ames Research Center in Mountain View, Calif. The resulting complex will be called the National Full-Scale Aerodynamics Facility, and will actually consist of two tunnels, one the existing 40-by-80-foot section, the other the 80-by-120-foot section being built. This new, larger wind tunnel is big enough to test a medium-size commercial transport with its engines running.

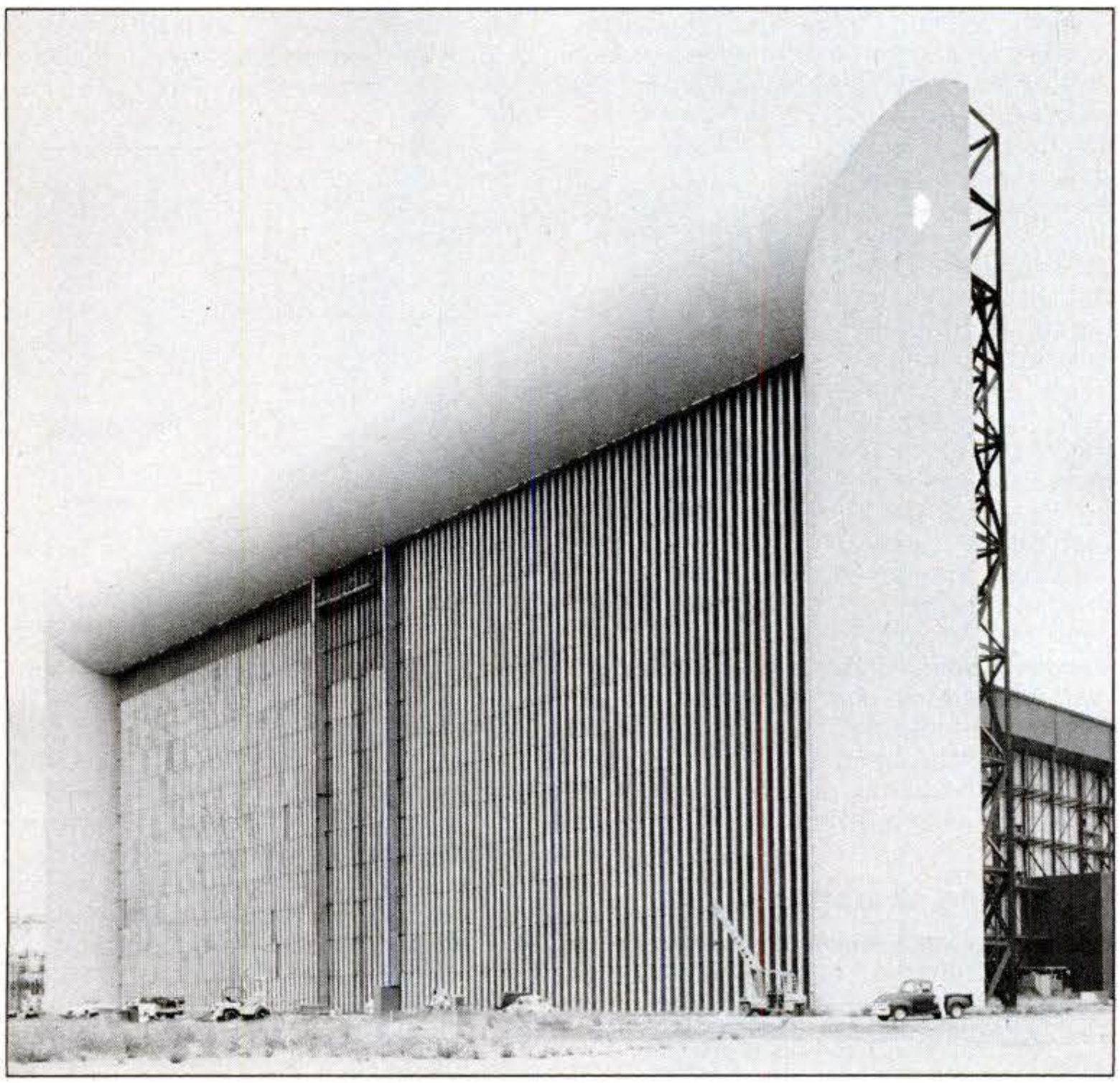
The huge air scoop fronting the new tunnel is 362 feet wide and 13 stories (132 feet) high. A better way to grasp its scale is to look at the size of the man with a pickup truck at the base of the monster structure.

Gold sandwiches

Materials scientists at the Department of Energy's Argonne National Laboratory have created a new class of metals with enhanced electronic and magnetic properties by making what are, in effect, gold sandwiches. They insert an ultra-thin layer of another metal—only a few atoms thick—between two thin outer layers of gold. These outer layers stretch the crystal structure of the metal or otherwise modify its molecular architecture to endow it with new and unexpected properties. For example, palladium is normally nonmagnetic, but has been made strongly magnetic by using the gold-sandwich treatment.

Argonne scientists engineer the new materials, known as epitaxial thin-film metal sandwiches, by vaporizing a given metal and depositing it in a uniform thin film—about 10,000 times thinner than a human hair—on a gold surface. As the film settles, it adopts the crystal structure of the gold as a kind of template; the metal atoms align themselves with the gold atoms to form new patterns. Palladium actually stretches its own crystal structure to fit the gold crystal, and it is this stretching that greatly enhances its magnetic characteristics.

Circuits incorporating these sandwiches could prove useful in many miniaturized electronic components, in computers, and in scientific instruments. Further research is proceeding to learn what new properties other metals may acquire when sandwiched between layers of gold, silver, and copper.



Aurora on Uranus

In the unlikely event that you could observe the heavens from the planet Uranus, you would see an aurora—and it would be red. That's the finding of astrophysicist John T. Clarke of the University of California's Space Sciences Laboratory in Berkeley. His discovery proves for the first time that distant Uranus, like Earth, Jupiter, and Saturn, is surrounded by a powerful magnetic field.

Auroras, like the scintillating northern and southern lights on our own planet, are caused when charged particles such as electrons from the solar wind are trapped and accelerated in a magnetic field, then strike atoms and molecules in the atmosphere. These, in turn, emit light whose color depends on the specific atoms hit. Earth's aurora borealis is mostly green because of the presence of oxygen in our atmosphere. On hydrogen-rich Uranus, the aurora would be red. Clarke detected the Uranian aurora using ultraviolet spectrometers aboard the Earth-orbiting satellite, International Ultraviolet Explorer.

Rare flare

Astronomers at New Mexico's Sacramento Peak Observatory have reported that the sun put on a spectacular performance during one 22-day period last June, highlighted by the appearance of five white-light solar flares. What makes this remarkable is that these flares are exceptionally rare; only about 50 had been reported in the last 100 years. By contrast, thousands of "normal" solar flares may occur during one 11-year cycle of solar activity. These regularly occurring flares can be observed only through special filters, whereas the rare type, as its name suggests, produces visible light. Dr. Donald F. Neidig, the Air Force Geophysics Laboratory scientist at Sacramento Peak, notes that the rare flare, which lasts only minutes, releases enough energy to run a city the size of Washington, D.C. for about 280 million years.

Single-crystal turbine blades

The only airfoils you likely think about in connection with an airliner are the wings themselves. But there are other airfoils inside those big jet engines—specifically the blades, or vanes, of the engines' whirling turbines. Now some of the new airliners will incorporate a significant change in these turbine blades. If you fly a Boeing 757, 767, or Airbus A310 in 1983, its Pratt & Whitney jet engines will have turbine blades made of just one single superalloy crystal, or grain. The result is increased engine power and efficiency from higher-temperature operation, and increased durability due to exceptional resistance to oxidation and corrosion.

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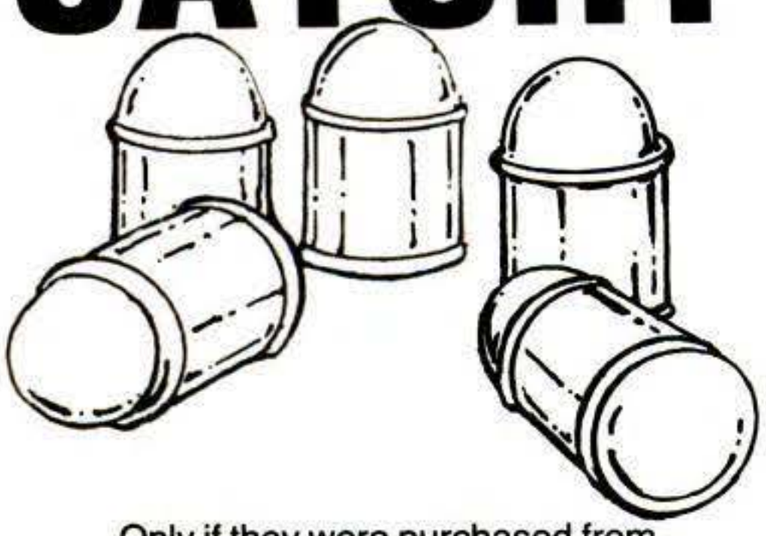

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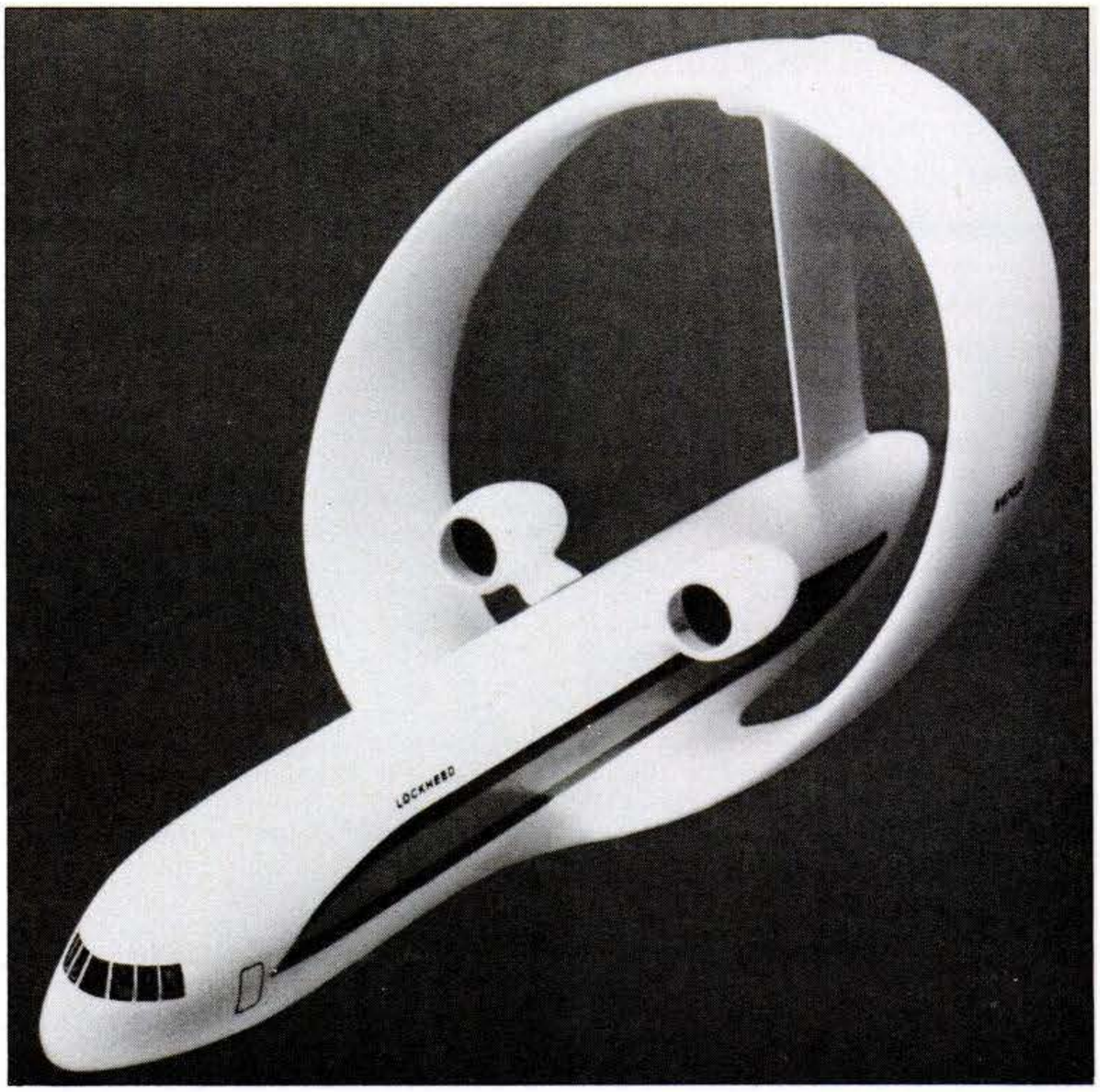
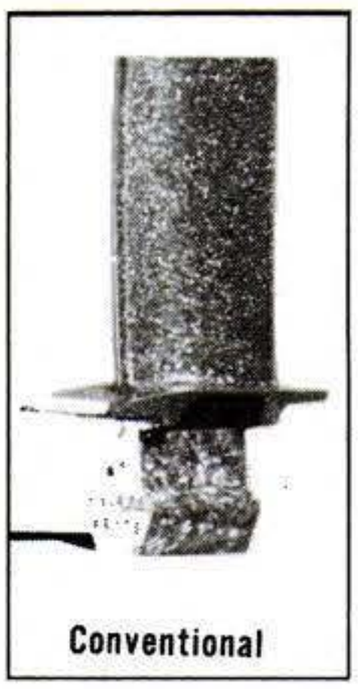
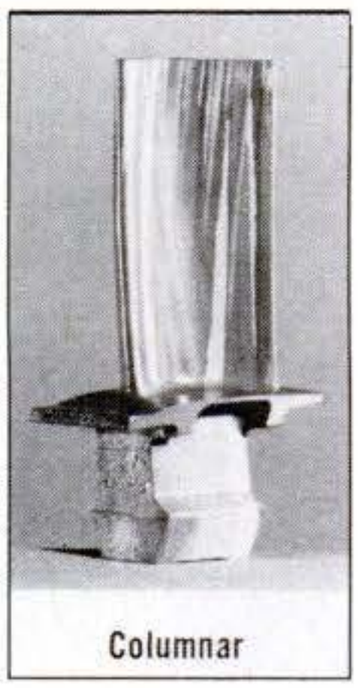
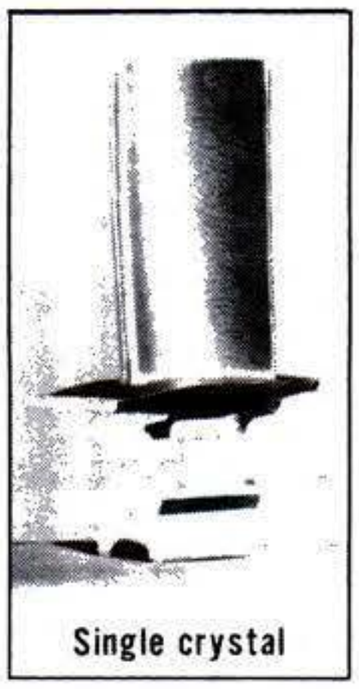


The single-crystal technology is an improvement over parts made from directionally solidified alloys (found in many current airliner turbofan engines), which in turn represented an advance over the conventionally cast alloys, with their random grain structure. The three turbine blades in the photos at right have been chemically treated to reveal their grain structure. From left to right, the first has been conventionally cast and has a random grain structure; the second (columnar) was cast with directional solidification—you can see the vertical patterns; and the third is a single-crystal component, whose grain-free structure is apparent. It is the boundaries between the grains, or tiny crystals, in alloys that leads to structural weakness.


Conventional


Columnar


Single crystal

Ring-wing aircraft

Rollo Smethers, a designer at Lockheed-Georgia Company, has proposed the unconventional wing configuration you see in the model above for aircraft of the post-2000 era. The Ring Wing is a swept wing attached to the fuselage conventionally, but meeting at the top of the ring with a forward-swept vertical surface. Objective: improved performance and efficiency. Smethers believes the Ring Wing will weigh only about half of a conventional wing, but will be capable of carrying the same load—up to 125,000 pounds. "With half the wing weight," he says, "the Ring Wing would be a much lighter airplane. A lighter airplane means lower procurement cost, and it would burn less fuel."

The concept of a ring-shaped wing is not totally new, Smethers points out. But earlier designs put the fuselage in the center of the ring. These designs could not cope with the problems of engine and landing-gear location, and the difficulty of controlling such an aircraft's flight. PS

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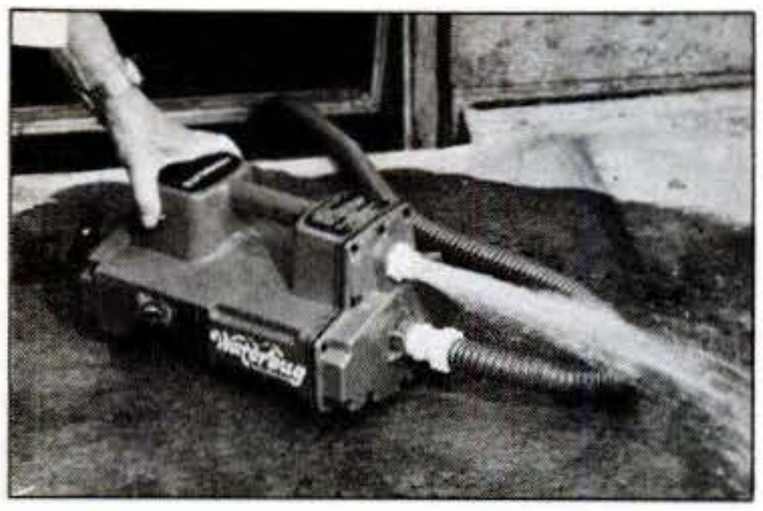
Gas engine drives
portable pump



My new Homelite Waterbug pump is so light you can carry it like a bowling-ball bag. Yet it can suck 1,500 gallons of water an hour out of a basement, boat bilge, or swimming pool. Or it can put 40-psi pressure into a hose to fight a fire, irrigate your lawn, wash down equipment, or fill a swimming pool.

The Waterbug is simplicity itself: A two-stroke engine connects directly to a pump impeller. You pour in priming water through the discharge opening, connect a garden hose to the discharge, and pull the starter rope. My trial showed that the Waterbug did everything claimed—but I'd like to see some improvements.

The suction hose supplied should be about four feet longer so it could reach a basement sump from outside a window. And the plastic pickup screen at the end of that hose should be weighted with a heavy metal collar to keep it from floating and losing suction. It would also be handier if you could reprime the pump by removing a plug on top of the housing instead of disconnecting the discharge hose.

Speaking of hoses, it would be less awkward and more efficient if the discharge came out on the side opposite the suction so one hose or the other didn't have to make a 180-degree turn. Finally, starting would be a lot easier if there were a centrifugal clutch between engine and impeller, as on most small, two-cycle-powered equipment. Then the engine could start freely and gradually pick up the load instead of starting against the resistance of priming water.

All in all, the Waterbug does a good pumping job, but it could be made more convenient to use. Price: $164.95. Homelite, division of Textron, Inc., Charlotte, N.C. 28217.
—*E. F. Lindsley*

From Chrysler in '84: turbo sports car

Can the K-car be reborn as a high-powered, sure-handling sportster?

By JIM DUNNE

Now that its K-car lines are firmly established, Chrysler is getting set to move into the hot, sporty-car field with a 1984 model to challenge Mustang, Camaro, and Firebird, as well as Supra, 280ZX, and other exotic imports. Code-named G-24, the car is a front-drive hatchback coupe with a special version of Chrysler's 2.2-liter four-cylinder engine, extra-firm suspension, and a completely different look inside and out from the K-car chassis it's based on.

Chrysler made a chassis prototype (a standard Reliant body with G-24 running gear) available to POPULAR SCIENCE recently. I examined it on Chrysler's proving ground in Chelsea, Mich., testing the car in high-speed maneuvers and acceleration from zero to 60 mph. I also checked for smoothness of ride and noise levels. I was impressed.

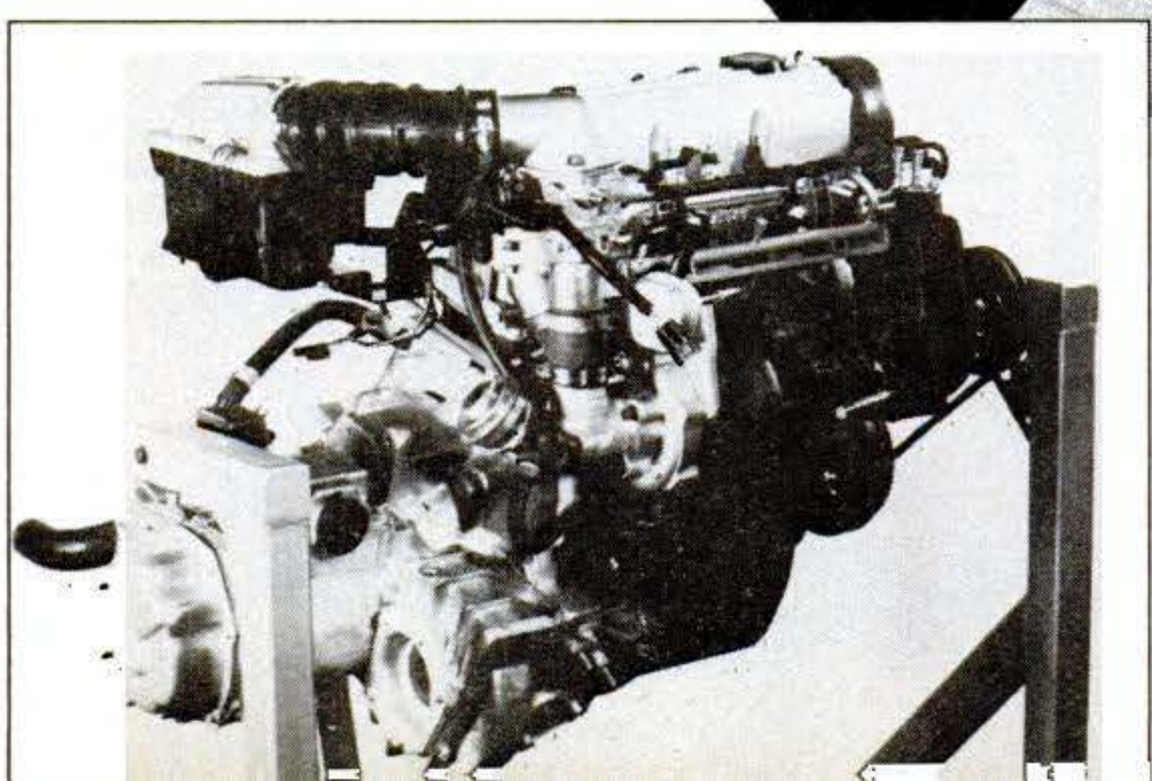
Handling is flat and predictable, with almost no hint of torque steer when the engine is switched from pulling to coasting. It actually feels more like a rear-drive car. The rear end gradually lightens up in high-performance turns, giving the driver plenty of warning to make corrections before the car gets out of line. The car's tightened suspension results in a firm ride on smooth roads; on uneven pavement, however, it's stiff.

Chrysler engineers say the turbocharged version of the G-24 will accelerate from zero to 60 mph in about eight seconds. Making manually timed runs, I was only able to get just under 10 seconds. I had trouble shifting from first to second—a problem that's inherent with the transmission, I feel. That slowed down my times.

The prototype I drove was equipped with Chrysler's own five-speed manual transmission, which uses a cable connection between the shift lever and the gearbox. The cable allows a change in shift-lever placement to fit different models. On the G-24, the shifter is placed more to the rear and higher up on a center console, close to the driver's hand.

The transmission's first four gears are close in ratio to give the car more power in low speeds. Fifth gear acts as an overdrive for better mpg.

Indeed, a big bonus with this sportster is fuel economy: With the five-speed transmission the turbocharged engine should get about the same EPA rating as the standard 2.2-liter engine—23 mpg city, 40 highway. However, you'll get less in actual driving, since the turbo uses more fuel when it comes into play. P 5



Beauty and the beast: G-24's aerodynamic sheet metal belies its K-car parentage. (Drawing is based on exclusive PS photos of a still-secret prototype.) Drag coefficient is 0.38, says Chrysler, down from the boxy Reliant's 0.47. Premium option power plant is a 2.2-liter (134.3 cu. in.) multiport-fuel-injection engine with a turbocharger (photo). Chrysler engineers claim the four-cylinder engine will produce 142 hp, a power-to-displacement ratio that recalls the thundering muscle cars.

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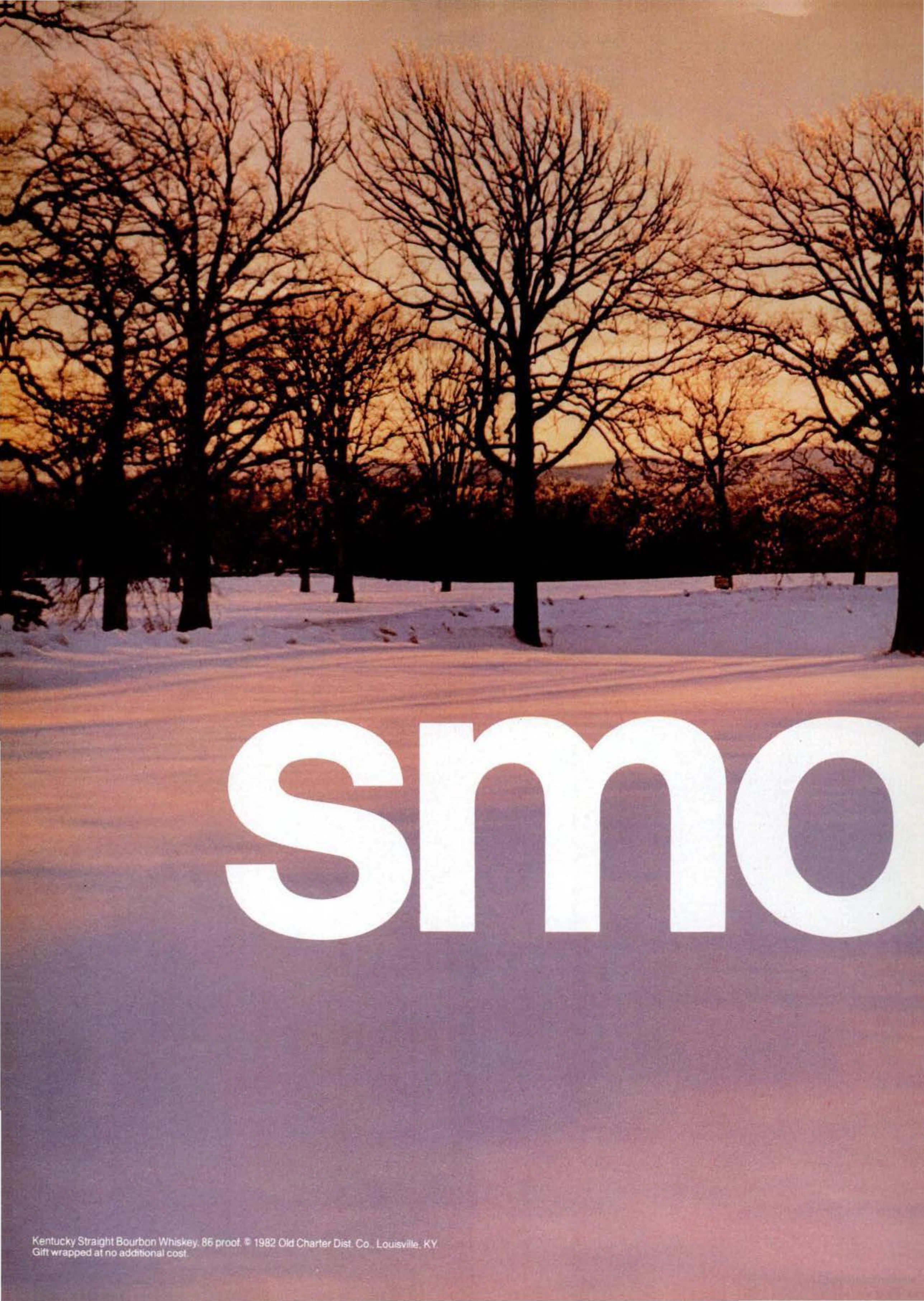

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More Comfort for Drivers

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The world's finest sheepskin brings real comfort to driving... and our price is outstanding for two months.

My name is Archibald Mason. I am a wool merchant from New Zealand.

New Zealand has more sheep than people. Our lambswool rugs are the finest in the world. Every year thousands of Americans travel to New Zealand and buy our lambswool rugs and car seat covers.

I began selling lambswool rugs by mail in the United States in 1978. Since then I have supplied many rugs to American homes and offices, and every week we receive further requests for rugs from people who cannot visit New Zealand just yet. I have often been asked by Americans if we can supply car seat covers. New Zealand was the first country to use lambswool car seat covers and we have been making and using them for over 20 years. About three out of five new cars in New Zealand have lambswool seat covers fitted when new, and this figure is even higher for luxury cars. I am the largest single supplier of custom made car seat covers to New Zealanders.

STRONG FIBERS

If the wool in the photo seems too plush for your car seat, don't worry. We trim the wool to an even ¾" for car seat covers, so there is enough length for those springy resilient fibers to hold you off the seat and allow air to circulate behind and beneath you; and the ¾" wool is short enough for easy care and laundering. Yes, laundering! New Zealand tanners have perfected 'chrome tanning,' which means your car seat cover can be thrown in the washing machine and washed like a woolen sweater. It goes back on your car seat as soft and resilient as new.

When you buy your car seat covers, you need to know they will last for years. New Zealand wool is the world's strongest — and the secret is in the nourishment of the sheep. We have an equable climate with adequate rain falling evenly through the year, so those lush, green pastures you have seen in our tourist publicity supply plenty of food for the sheep all year. No summer droughts, no harsh winters. The wool grows into even, strong fibers. When your friends run their fingers through the wool in your seat covers, they may find it incredible that the world's longest-lasting wool can be so soft. But you will know, as your seat covers give you comfort for year after year, that you have bought from the people who know how to make the best seat covers.

THE BEST METHOD

But think about the fixing method. Some of the seat cover advertisements I have seen in the United States worry me — the fixing systems they are offering are clearly inadequate. As you slide in and out of your car seat, there is a tendency for the seat cover to move sideways on the seat, and it may move out of position. It took us many years of experience in New Zealand to develop the best fixing method, which holds the seat covers firmly in place without moving. We use color-matching straps in exactly the right places, and we even have light friction strips on the back of each cover to hold them in place.

Wool is a great insulator. When you enter your car on a hot day, the wool seat covers never feel hot, unlike the synthetic materials often used in car seats.

On a cold day, vinyl or synthetic materials drag the heat rapidly out of your body. Wool doesn't do this — wool adjusts slowly to your temperature, at the same time cradling you in thousands of soft, springy fibers. A great way to start any drive.

LUXURIOUS

But the greatest benefit is the air circulation. No matter how heavily you sit on a sheepskin seat cover, there is always air between the wool fibers, separating you from the car seat. As the air moves behind you, it carries away the moisture given off by your body. No more sticking to the seats, or damp clothing on a hot day. You may even find you use your air-conditioning less, and thus conserve fuel. New Zealand cars seldom use air conditioning.

My seat covers cover the back rest and seat cushion, and they are strikingly beautiful. They will enhance the interior of your automobiles, and they will protect your car seats from scuffing and damage.

We have seat covers in stock for all American and imported cars. They are in matched pairs to suit the front seats of your car. U.S. Customs have been paid and we deliver to you by UPS from our nearest warehouse within a few days of dispatch.

SPECIAL OFFER

Our factories are slightly overstocked and the New Zealand Dollar is low at present. So we can bring you this special offer for orders received by January 31st, 1983. We may be unable to hold this price after that date.

Order a pair of seat covers in tan, charcoal gray, honey or white and pay only **$115.00** per pair. (Singles **$60.00** each.) Please add **$5.50** per pair or **$3.50** per single for handling and delivery.

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OF NEW ZEALAND
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"The rug in the photo is our white queen-size rug of never-shorn lambswool. It measures over 5 ft x 2 ft and our price is only $99.50 plus $5.50 delivery. Try our rug— it will be the nicest thing you ever did for your feet."

In Hawaii, call 523-5808 or visit our shop, The Prides of New Zealand, Ala Moana Center

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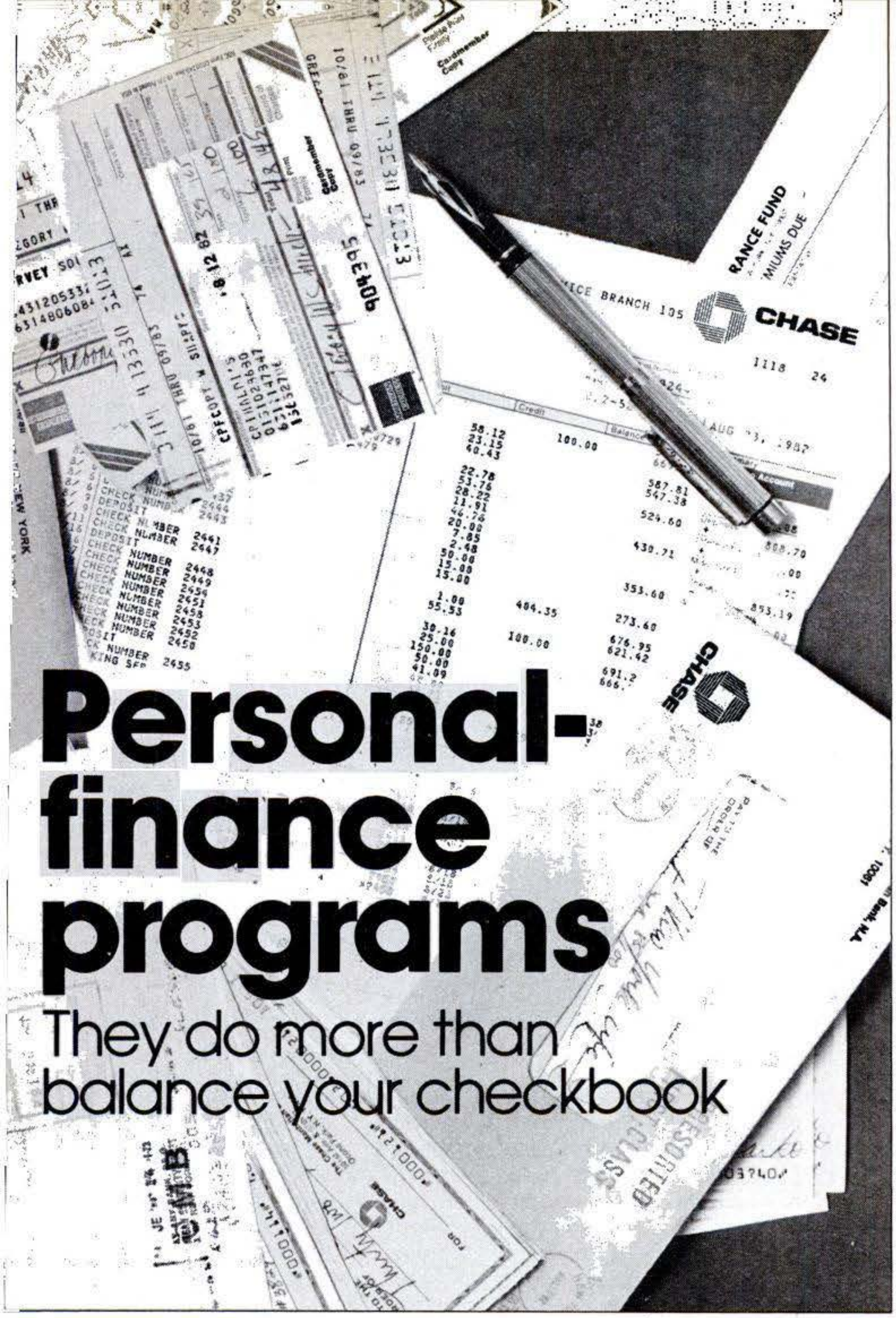

Personal-finance programs

They do more than balance your checkbook

Now your computer gives you instant data on all your money matters

By GORDON MC COMB

It seems so simple: Enter the date, check number, amount, and name. Yet if your checkbook is anything like mine, it's hard to believe how something so simple could get so fouled up.

And then there's (gulp!) tax time—the frantic search through past records of doctor bills, clothing expenses, business luncheons, interest payments, and all the other write-offs that could—if found—turn the tax tables in your favor.

Need help? You've got it: With the right software, your personal computer can take care of all your money matters. Specifically, the new personal-finance programs will:

- Record *all* checking-account transactions and include automatic deposits, transfers, and charges.
- Print out a check register or transaction sheet after completing the computations.
- Maintain running balances on credit cards, house payments, car and boat loans, and other regularly recurring payments. Keep track of whom to pay, when, how much, and the amount you still owe.
- Allow you to search for specific information, then display or print out any transaction by date, check number, payee, amount, or category.
- Provide graphs for easy interpretation of statistics, such as bar graphs for budgets.

Choosing a program, however, is a lot harder than actually using it. Although all are designed to balance your books, all do it differently and many have additional capabilities that you may or may not use. Here's what I learned.

Personal-finance programs come on either cassette tape, diskette, or cartridge such as that made for the Texas Instruments 99/4A. The cassette method is slow but usable. A disc-based financial system can call up information from your old records in a flash. After you've had the program for a few years and have amassed bundles of old information, you'll appreciate the greater speed of the disc. Cartridge-based systems require some sort of magnetic storage media that will allow you to save your data for future reference. Depending on your system, either a cassette tape or diskette is used to save your financial information.

Once you've loaded the program into your computer, you'll be greeted by a "main menu," a directory of all the major operations the program will do. Home Accountant, for instance, gives you several categories to choose from, such as TRANSACTIONS, GRAPHS, BUDGETS, PRINTED REPORTS, and so forth. But like many personal-finance programs, the first time you use it you need to "initialize" your system. You must do this before you can load any data or have it do any computations.

The initialization process can be long and tedious, but it helps ensure a match between the program and your computer system (memory size, printer type, etc.). The more complex the program, the more initializing information will usually be required. Maxi-Cras asks for all sorts of seemingly unimportant information (unimportant to you, very important to the program) such as dates, master passwords, disc-drive-track capacity, and printer null characters. Some of the questions can be a bit complex, and you may need to dive into your computer's instruction manual or call your dealer for help.

Then comes the quite lengthy task of entering all pertinent data: your name, address, account numbers, starting balances, amounts due, and more. At this time, you'll also need to name the categories of your budget (medical, clothing, food, etc.), if the

Continued

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THE GIFT FOR OCCASIONS YOU'D LIKE TO FORGET.

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For those of you who have ever fumbled in the dark for a flashlight, only to find the batteries dead, Black & Decke has the perfect gift.

The Spotliter™ Rechargeab Light. A powerful light that's always charged and easy to find. Because it stores neatly on the wall in its own recharging unit.

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program will allow it. Some programs, such as Home Accountant and Financial Management System III, will allow you to name up to 100 categories. Other programs don't allow you to choose your own categories at all but instead give you standard ones. This is no problem if your budget categories aren't too unusual.

Once you've initialized your system, you're ready to go.

Balancing act

One of the handiest features of personal-finance programs is their ability to maintain checking accounts. You can list every check you write, include its number and the amount (which will automatically be deducted from your account balance), and indicate to whom it's made out and what its budget category should be.

When you get your checks back from the bank, you can then indicate if the check has been returned or is outstanding. Reconciling your checking account is now easy. The computer ticks off each check that hasn't cleared the bank, adds or subtracts the amounts of deposits, check charges and other bank fees, and does all the bookkeeping. What took me an hour to complete is now done in seconds.

Some programs also handle credit cards and cash (Cash? What's that?) in the same manner as your checkbook. With Home Accountant, for example, every credit-card and cash purchase is recorded. It includes the seller's name, the item, amount of purchase, and the item's category—food, shoes, etc.

The real advantage of computerized budgeting is that you can ask for a rundown—by category, payee, or any other topic—and the computer will automatically display all this information. Some of the more complex and expensive programs allow you to search and list certain types of transactions. For example, say you want to know how much you've spent on clothes in the past two months. You simply ask the computer to go back through the credit-card, cash, and check transactions for the past 60 days and look for any purchases that were for clothing. It will find only those marked "clothing" and give you a rundown of each transaction. It will even total the expenditures for you.

Most finance programs will allow you to use any numbers or words in its search mode. You can search for names of payees, dates, amounts over $100, and so forth. It's nearly automatic, and it takes no time at all. For the first time you can have an accurate account of what you spend where. Personal-finance programs allow you to quickly ferret out the reasons for an "unexplained" drain on cash.

You can also perform split transactions with some of the more elaborate programs such as Maxi-Cras, Financial Management System III, and Home Accountant. This is perfect for tax time or if you do a lot of consolidated buying. Split transactions work this way: Say you bought $55 worth of computer gear at a department store, but on the same check you also have $22.50 for cleaning supplies for your house. You can enter the same transaction in two different categories on the computer, yet the program will treat it as one check. Check No. 2775, for $77.50, will be "split" between computer goodies and housekeeping supplies. When it's time to see how much you've spent on what, you'll have an accurate tab on all your expenditures.

Personal-finance programs have, for the most part, a manual file system; only Home Accountant is fully automatic. If you write a check for one

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of your credit-card payments, Home Accountant will automatically deduct the amount from your checking account and credit the proper credit-card account. There's no need for you to do both transactions manually. However, you need to be careful with this automatic program; you don't want to duplicate the work the computer has already done for you. With a manual system, you must go through the program and update each account. Normally, this is not terribly inconvenient—unless you have a lot of dual transactions.

Personal-finance programs also give you the opportunity to create printed reports of your budgets and expenses. Some, such as Personal Finance Manager from Apple, allow you to print whatever you see on the screen. Others, such as Home Accountant and Financial Management System III, generate separate reports that can be printed on paper.

A typical printout might be a personal balance sheet for the past month, quarter, or year. It shows facts and figures about your actual cash on hand and other assets, along with credit cards and other liabilities. Another type of printout might be an income-and-expense summary, outlining your total income and expenses for the months or periods selected.

Several programs, such as Chequemate and Home Accountant, provide graphs and charts for easier interpretation of your financial information. A "budget vs. actual expenditures" bar graph, for example, could visually show you how well you're sticking to your guns, while a trend analysis can show how much you've spent on your car in a one-year period. You might see how you tend to spend less in May, but come June and July you spend much more than your budgeted amount. Such a graph could indicate a need to increase the budget for household expenses, heating, air conditioning, or clothing at certain times of the year.

Hard look

Personal-finance programs come in a variety of styles, differentiated mainly by the number of special tricks they can do. Usually—but not always—the more tricks, the higher the price tag. There is an upper limit to the number of features a program can have and still be worthwhile to *you*. An expensive program loaded with capabilities may be no better for you than a cheap program that does only one or two jobs. It's all a matter of your needs. For example, two programs, Personal Finance Master and Home Accountant (both priced at $74.95), have basically the same features. The real difference is in how they operate. Personal Finance Master provides a great deal of freedom when manipulating data because its operation is totally manual. Home Accountant is somewhat less versatile but performs many transactions automatically. The real value of either program is subjective. If you need manual operation, you may not be able to get much use from Home Accountant. On the other hand, if you prefer automation, Personal Finance Master may leave you a bit worn.

There are also specialized "financial decision maker" programs. Both Texas Instruments' Financial Decisions and Creative Software's Decision Maker allow you to enter a set of financial variables into the computer. The programs will then compute the best possible option or options open to you. These programs have limited use, but are handy when you'd like to know how much a loan will cost and don't know the arithmetic to arrive at the right figures.

Continued

WINTER'S CALL

the snows of winter start swirling, to trade wheels for skis and take a special kind of Quicksilver ultra- ing. Since snowmobilers often ride the wind faster than ultralighters, w you can bundle up for protection ndle off for an invigorating day of flight. If your MX has the optional airing, you'll find you can really fly tably.

ience the excitement of flying over itened countryside in Eipper's ver- lane for all seasons. You'll be amazed quickly you can master winter fly- ntact your local Eipper dealer so he ow you the thrills of "over the fields Then let him explain how you can special "Frostbite Flyer" patch in a lver, the world's finest ultralight.

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Features alone shouldn't persuade you to purchase one program over another. The ease with which the software performs its magic is a vital consideration, too. Financial Management System III (at $120) makes fancy graphs and will print out just about any type of report you may ever want to know about yourself. On the other hand, it's clumsy when it comes to split transactions. Home Accountant prints out fewer types of reports than Financial Management System, but handles split transactions nicely.

Some programs may not allow full versatility, yet with a bit of ingenuity you may be able to get the proper accounting done despite their shortcomings. For example, Apple's Personal Finance Manager ($74.95) doesn't have a split-entry feature. You can do the split yourself, however, by entering two or more transactions with the same check number. Also, there's no way you can enter automatic-teller withdrawals with Personal Finance Manager since the program insists you give every checking debit a check number. There's nothing wrong with assigning all automatic withdrawals the number 000, though.

Only one program, Maxi-Cras ($99.95), allows you to transfer the information you have entered for one program into another. Specifically, Maxi-Cras enables you to transfer your financial files into an "electronic spread sheet" program called VisiCalc, widely used in business.

One test I performed on all of the programs I reviewed was a simulation of the dreaded night of April 14. [Look for a feature on special "tax preparer" programs in a forthcoming issue of PS.] I found that those personal-finance programs with a search or list-by-category feature were the most useful. When I needed to know how much I spent on medical bills, I could easily ask the computer to search for only those dealing with medical purchases and payments. Others having a similar by-category feature simply listed the totals for each of my expense categories.

Although nearly all of the moderate-to-expensive programs I tried have either the search or by-category feature, some programs, such as the Dynacomp Family Budget, were harder to use because the information wasn't as clearly defined on the screen.

I also fed varying amounts of information to each program I tested. I found that the least-expensive programs had a hard time juggling a lot of numbers, even when I didn't exceed the maximum number of categories allowed. They also seem to be of little help when a moderate-to-heavy amount of data is involved. They work slowly and don't allow enough flexibility to handle one's financial data. But I also found that more expensive programs are a waste of money when only a small amount of information is used: I hardly had a chance to use any of their special features.

Bottom line: There's a personal-finance program for everybody. Finding the right one simply means trying out a few first. The table that accompanies this article will guide you in your shopping. PS

PS buyer's guide to personal-finance programs

Program name	Distributor or publisher	List price ($)	Computer	Minimum memory	Medium†	Printer output	Categories	Graphics	Auto	Key features
Budget Management	Radio Shack	19.95	TRS-80 Models I, III	16K	C or D	Yes	60	No	No	User-changeable categories
Car Costs	Creative Software	19.95 (C) 24.95 (D)	VIC-20; Atari 400, 800	VIC: 5K; Atari: 16K	C or D	Yes	*	*	*	Specialized program that provides automobile-fuel-consumption-and-costs summary
Chequemate	Masterworks Software	39.95	Apple II	48K	D	Yes	Any number	Yes	No	Provides accounts-payable function; high-resolution bar-graph display; check sorting
Decision Maker	Creative Software	19.95 (C) 24.95 (D)	VIC-20; Atari 400, 800	VIC: 13K; Atari: 16K	C or D	Yes	*	*	*	Specialized program that provides purchase option alternatives
Family Budget	Dynacomp	34.95 (CP/M disc 37.45)	All major brands	16K (Atari requires 24K)	D	Yes	50	No	No	Provides easy review; two separate sections of budget and charge accounts; account names can be changed in program listing
Financial Management System III	Computerized Management Systems	120.00	Apple II	48K	D	Yes	100	No	No	Search capability; extensive report printouts
Home Accountant	Continental Software	74.95	Apple II	48K	D	Yes	100	Yes	Yes	Prints checks; full-search capability; maintains up to five checkbooks; maintains transaction history
Home Accountant Plus	Continental Software	150.00	IBM personal computer	64K	D	Yes	100	Yes	Yes	Same as Apple version but includes forecasting module for future financial strategies
Home Financial Decisions	Texas Instruments	29.95	TI 99/4A	16K	CT	*	*	*	*	Special program that evaluates purchase options
Household Budget Management	Texas Instruments	39.95	TI 99/4A	16K	CT	Yes	99	Yes	No	Search capability
Household Finance	Creative Software	34.95 (C) 39.95 (D)	VIC-20; Atari 400, 800	VIC: 5K; Atari: 32K	C or D	Yes	16	Yes	No	
Maxi-Cras	Adventure International	99.95	Radio Shack TRS-80 Models I, III	48K	D	Yes	223	No	No	Prints checks; split-entry feature; provides "audit trail"
Money Manager	Acorn Software Products	39.95	Radio Shack TRS-80 Models I, III	32K	D	Yes	100	No	No	User-defined categories
Personal Finance	Radio Shack	14.95	Level I TRS-80	4K	C	No	32	No	No	
Personal Finance	Radio Shack	39.95	TRS-80 Color Computer	4K	CT	No	26	No	No	User-changeable categories
Personal Finance Manager	Apple Computer Special Delivery Software	74.95	Apple II	48K	D	Yes	24	Yes	No	Search capability; prints out information as seen on screen; handles up to a dozen credit cards
Personal Finance Master	Spectrum Software	74.95	Apple II	48K	D	Yes	100	Yes	No	Search capability; prints personal balance sheet
Personal Finance System	Dynacomp	39.95	All major brands	24K (Northstar requires 32K)	D	Yes	*	Yes	No	Full checkbook control; sorts checks alphabetically by name of payee

†C=cassette; D=disc; CT=cartridge; *not applicable

SOURCES OF HOME-FINANCE SOFTWARE

Acorn Software Products, 634 N. Carolina S.E., Washington DC 20003; **Adventure International,** Box 3435, Longwood FL 32750; **Apple Computer Special Delivery Software,** 10260 Bandley Dr., Cupertino CA 95014; **Computerized Management Systems,** 1038 Cadiz Dr., Simi Valley CA 93065; **Continental Software,** 11223 S. Hindry Ave., Los Angeles CA 90045; **Creative Software,** 201 San Antonio, Mountain View CA 94040; **Datamost,** 9748 Cozycroft Ave., Chatsworth CA 91311; **Dynacomp, Inc.,** 1427 Monroe Ave., Rochester NY 14618; **Howard Software Services,** 8008 Girard Ave., Suite 310, La Jolla CA 92037; **Masterworks Software,** 1823 W. Lomita Blvd., Lomita CA 90717; **Radio Shack,** 1600 One Tandy Center, Ft. Worth TX 76102; **Spectrum Software,** Box 2084, Sunnyvale CA 94087; **Texas Instruments,** Box 53, Lubbock TX 79408.

If you own a telephone modem, you can "join" one of the following dial-up services for access to any of several personal-finance programs (they actually stay with the service's computer; your system functions as if it had the program loaded into it): **Source Telecomputing Corp.,** 1616 Anderson Rd., Mc Lean VA 22102; **CompuServe,** 5000 Arlington Centre, Columbus OH 43220.

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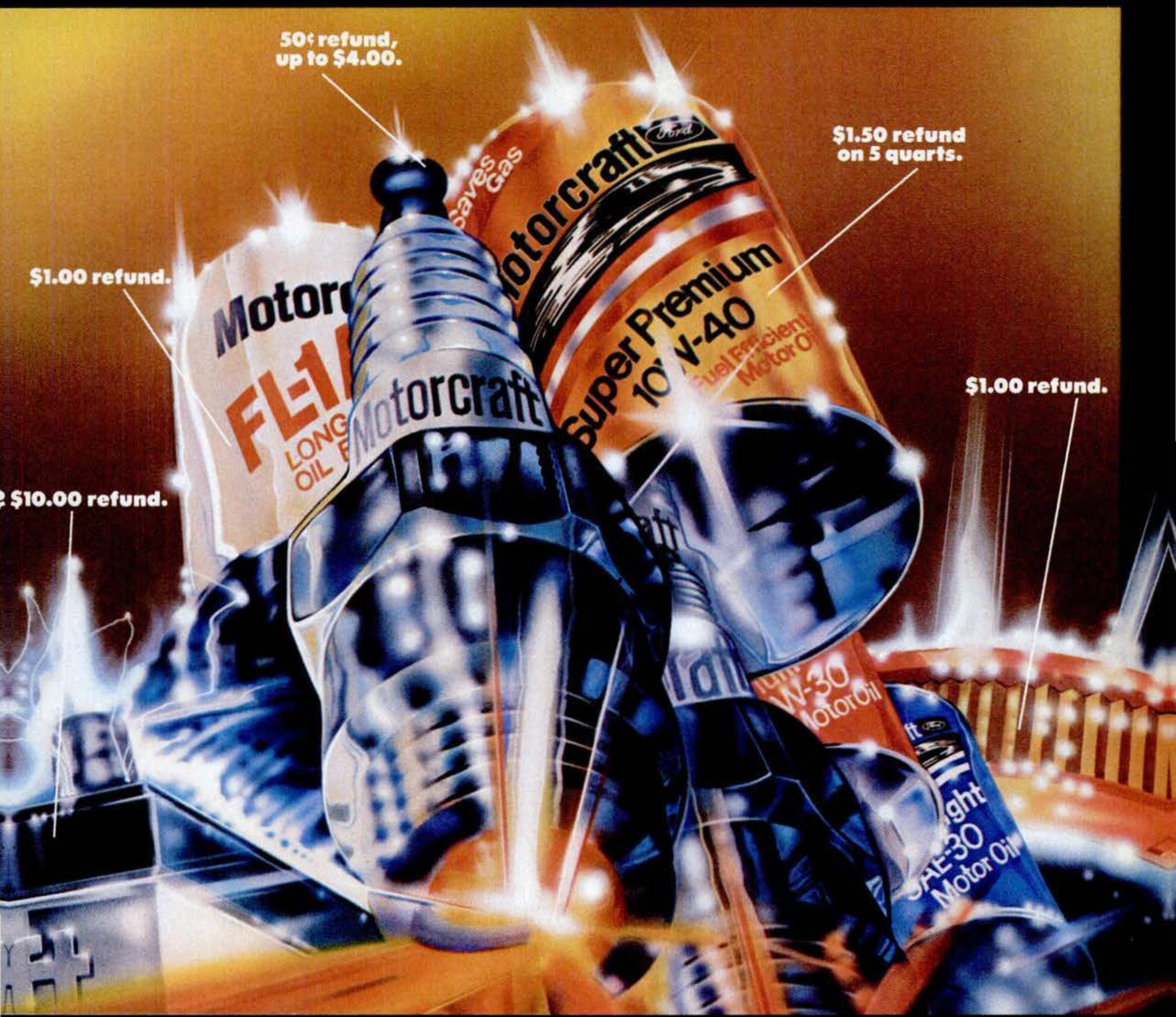

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Popular Science

PS | What's News

What is it about the shape of a beautiful airplane that makes the heart beat faster and the breath come in gulps? I don't know, but I confess that I am so affected and have been since childhood. That's why I was particularly excited when I first saw the plane on this month's cover. But, as you'll learn reading Ben Kocivar's article, beauty is only one of this plane's qualities. It also delivers astonishing performance. As a straight sailplane, it gives a glide ratio of about 35 to 1—that's championship class. But even with the engine pod in place, it still gets about 25 to 1, which is more than respectable.

And, of course, this plane is just one of a large group Ben reports on. The recent air show in Hanover was full of exciting craft displaying all kinds of new technological magic, and many of them are described in the article, which starts on page 72.

Run, the universe is decaying

In the heart of a 134-ton iron detector deep under Mont Blanc on the border between France and Italy, a proton recently ceased to be. Or that's what physicists think happened. And if it did, the physics text books will have to be rewritten.

Perhaps 25 billion years ago, the universe was born in a flash of unbelievable heat and pressure. Working with the remnants of that mammoth explosion—our universe—physicists have been able to draw up a remarkably detailed picture of what must have happened in the opening seconds of the creation. Among other things, all particles that make up the matter of the universe were identical, and there was only one force present. Gradually, as the universe cooled, many different particles evolved and various forces—gravity, electromagnetism, and what physicists call the strong force and the weak force—came into being.

But if physical law is to be consistent and complete, all of these particles and forces should be able to be encompassed by a single theoretical framework, accounting for everything. In recent years, physicists have been working to develop such schemes, which fall into the general classification of grand unification theories. Unification theories predict several things. All of the magnetic particles we know about today have two poles. But the theory predicts that a strange particle called a magnetic monopole must also have been formed. Experimenters at Stanford University think they may have found one of those hanging around since the creation, but they are unsure.

Another thing predicted by the unification theories is that protons—which, as the fundamental particles of matter, were thought to last forever—have a finite lifetime. After a while, they will decay in a little poof of pure energy. If that is true, proton decay should be detectable. Hence the 134 tons of iron under Mont Blanc. Hence also the 10,000-ton water-based detector under Lake Erie [PS, Dec. '81]. And hence a half-dozen other massive and expensive detectors elsewhere around the world. If a proton is absolutely and unambiguously detected in the act of decaying, that observation will lend great weight to the unification theories and the general structure of nature as predicted by these theories.

The quest is difficult because theory predicts that the half-life of a proton is about 10^{31} years. That's 10 followed by 31 zeros, or some 10,000 billion billion billion years. To put it another way, one of the billions of protons in your body would be expected to decay during your lifetime. Thus if you want to have any chance of seeing such an event, you've got to be watching a lot of protons. That's why the detectors each contain hundreds or even thousands of tons of material.

It is not certain that the event under Mont Blanc was actually a proton decaying and not a neutrino from outer space slamming into an atomic particle in the detector. But physicists will be watching the detectors closely over the next few years trying to decide. If they find that small, unlikely event and document its existence even a few times, our picture of the universe and its basic rules will forever change.

Solar kilowatts

A Stirling engine, using sunlight as a heat source, has generated energy at an 18-kilowatt peak rate and fed some 175 kilowatt-hours of electrical energy into the public utility grid. The Stirling engine was developed by engineers from United Stirling of Malmo, Sweden, and was tested at the Advanced Components Test Facility at the Georgia Institute of Technology in Atlanta. That facility contains a field of 550 one-meter-in-diameter mirrors, which can concentrate 325 kilowatts of solar thermal energy on a target in a tower six stories above the ground.

The Stirling engine [PS, June '78] is an external-combustion device that runs by alternately expanding and contracting a working fluid—usually helium—to move pistons. It can use any heat source—burning fuel or solar, among others. Its big advantage is its high efficiency. Engineers hope to be able to install solar-Stirling generating plants at a cost of $1,500 per installed kilowatt by 1985. That compares with about $8,000 currently for photovoltaic power, although that cost should drop in the future, also.

Brainier computers

The president of Bell Laboratories says that computers will become more powerful because we'll be able to jam ever greater numbers of components into smaller amounts of space. Ian M. Ross predicts that we will be able to squeeze one million components on a microchip in 1983 and perhaps four million by the end of the decade. But to achieve even greater progress, says Ross, we'll have to learn to imitate nature when it comes to computer architecture.

"If we look to biological systems for clues to designing our future silicon-based systems of intelligence," Ross says, "we see the need for a new architecture. Nature's awesome power, evolved over billions of years, lies in its replication and interconnection of many small processors—like those in human cells. These processors, highly specialized in their function, are interconnected in networks that provide for a range and variety of activities that no single computer, regardless of its speed, could provide."

What goal might computer designers using such techniques logically aspire to? Ross predicts that it might be possible to build a computer that would match the human brain in capacity, size, and power by the end of this century.

Editor-in-Chief

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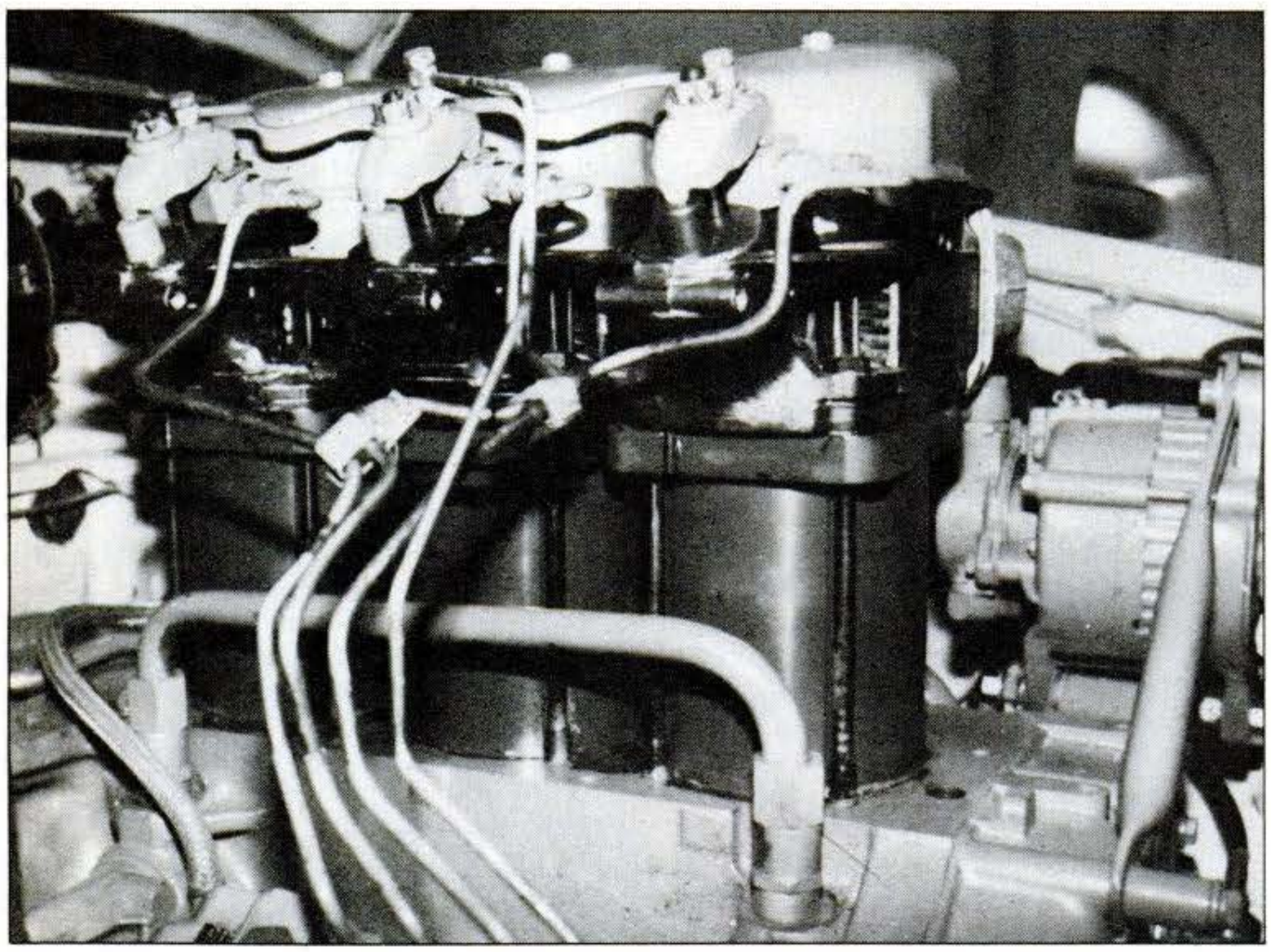
From Japan's labs: ceramic diesels



Hybrid ceramic diesel built by Kyoto Ceramic in Japan (top) is based on an air-cooled industrial engine. Above is an Isuzu Gemini sedan fitted with the diesel for demonstration. An all-ceramic engine could be commercialized by 1990.

A new era of engine technology? Here's the first ceramic auto engine

By JOHN HARTLEY
DRAWING BY RUSSELL VON SAUERS

TOKYO

The engine sprang to life. I watched as the young reporter pushed the shift lever forward. "Is it all right?" she asked the engineer anxiously. "The car is shaking." He nodded, and she started off on a very slow round of the test track.

With that inaugural lap, the Japanese entered the ceramic-engine race, albeit with a shake and a bang. But the point was made: A car with a ceramic engine can be built and run—the way to a new future is open.

Why are ceramics, little more sophisticated than the material used to make cups and saucers, being heralded as the engineering materials of the 1990's? First, the raw materials are plentiful: You start with sand. Second, since in most heat engines higher operating temperatures produce greater efficiency, a new generation of efficient engines may be possible because ceramic components can withstand much higher temperatures than those made of metal [PS, March].

But there are snags. It's not easy to make ceramic parts without a lot of expensive machining. And they can develop sudden cracks and fail catastrophically.

At last, though, solutions to those problems are beginning to appear, owing largely to research in Japan. I watched a simple test in the laboratories of Kyoto Ceramic in Japan that demonstrated the advantages of ce-

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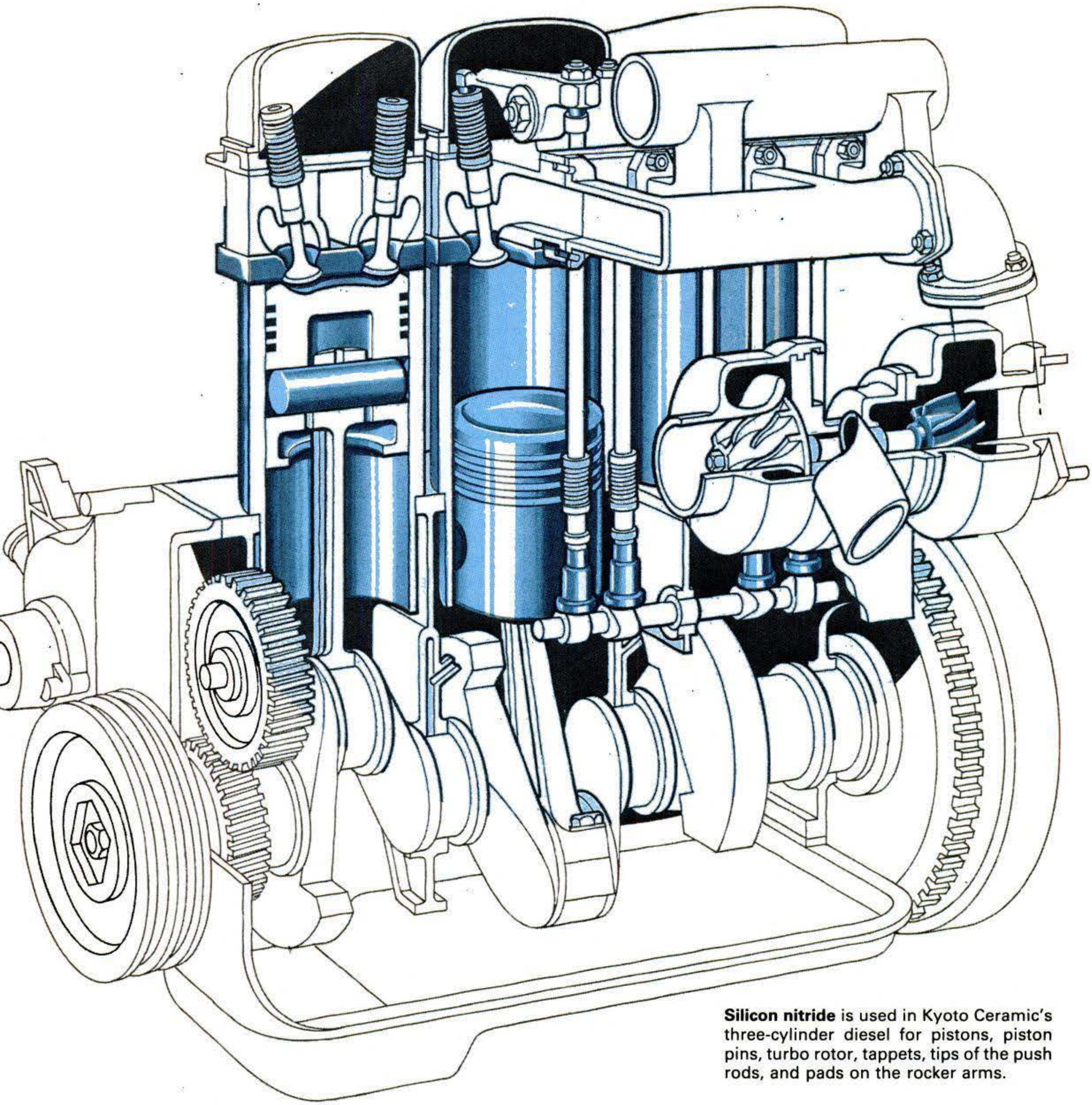

Silicon nitride is used in Kyoto Ceramic's three-cylinder diesel for pistons, piston pins, turbo rotor, tappets, tips of the push rods, and pads on the rocker arms.

ramics. A piston made of aluminum and one of silicon nitride, a ceramic, were heated side by side. The temperature rose to around 500 degrees F, but the result was unspectacular: Neither piston glowed or changed color. The temperature rose higher. Still no noticeable changes. Then suddenly the center of the aluminum piston seemed to crumble; a hole in its middle appeared as the metal melted under the extreme heat. But the ceramic piston remained unaffected and survived at much higher temperatures.

How does the heat resistance of ceramics help engineers design better engines? The heat that can be converted into useful work is the critical factor. Because conventional components can't withstand extreme temperatures, a large part of the heat in an engine has to be dissipated, which means the lost heat is not being applied as an expansive force—that is, it's not being put to a useful purpose (expanding gases to drive pistons or roll turbines).

Under the basic laws of physics governing heat-engine operation, maximum theoretical efficiency is determined by the temperature difference between the heat in and heat out. In practice, this means that the hotter an engine can run, the closer it can approach its optimal theoretical efficiency. That's where ceramics come in. With ceramics, a cooling system is not needed: More heat goes into the exhaust, where it can be recovered.

How? "We can use turbocharging or turbo-compounding," says Yoshiteru Hamano, managing director and head of research at Kyoto Ceramic. In turbo-compounding, the turbocharger shaft is geared to the flywheel so some energy can be diverted to the drive train, some can be used to boost the pressure of air entering the engine.

The best candidates: diesels

Unfortunately, the typical gasoline engine does not respond well to higher operating temperatures. If the piston and cylinder head get too hot, the engine will "knock," or detonate, and

Continued

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the piston will probably be damaged. The most likely class of engine to benefit from ceramics is the diesel.

Who will win the race to produce the first commercial ceramic engine? The front-runners in Japan are NGK Insulators, Kyoto Ceramic, and NGK Spark Plug.

If the Japanese build a production ceramic diesel before anyone else, it will be partly because of the way they go about their research. It works like this: A government-sponsored organization made up of all makers of industrial ceramics does a certain amount of basic research. The idea is to provide a platform of shared knowledge. Then individual companies work separately (and competitively) to develop certain materials or products.

The work being done by NGK Insulators and NGK Spark Plug demonstrates the efficacy of this approach. Both are involved in the government-sponsored research project, but although they are in the same group, the two companies are working on completely different materials. And their respective researchers claim they do not know what is going on in the other company.

Leader of the pack

Kyoto Ceramic seems to have made the most headway in Japan—it was the first company to demonstrate a car with a ceramic engine (with that lap around the test track). The engine is based on a Deutz three-cylinder 2.8-liter (170 cu. in.) industrial unit. "We chose it because it is quite small and air-cooled," explained Yoshiteru Hamano.

"The head plating is about ½ inch thick," Hamano continued, "and the valves seat directly in it." Actually, the engine, which has no cooling system, has only run a few hours—and never on a test bed. "It was built for demonstration only," admitted Hamano. But as it stands, the engine will travel 30 percent farther on a gallon of fuel and is 30 percent lighter than its conventional counterpart.

How soon will we see an all-ceramic engine? "Maybe not for seven or eight years," Hamano concedes, but he reckons Kyoto Ceramic is well on the way to solving the engineering questions.

The problems? In all materials there are imperfections that sneak in during manufacture. These take the form of tiny pores in the material surface. Explains Hamano: "With metals, pore sizes of 100 to 300 microns [millionths of a meter] are acceptable. With ceramics, the pores must be no more than 10 to 30 microns."

Kyoto Ceramic has developed ways of forming silicon nitride and silicon carbide with smaller pore sizes, and the company is working on new formulations for further improvements.

One of Kyoto Ceramic's main rivals is NGK Spark Plug. Last year, that company demonstrated a 50-cc (three cu. in.) single-cylinder, two-stroke gasoline engine, the parts of which were virtually all made from ceramics. Only the bearings and a few small parts were metal—cylinder, head, piston, connecting rod, and crankshaft were all made from silicon nitride. The crankcase was made with alumina. The use of alumina gives an inkling of NGK Spark Plug's background: Alumina is the material used for spark-plug insulators, which the company makes by the million—some 20 million a month, in fact.

But NGK Spark Plug is working mainly with silicon nitride for engine parts. Research is headed by Hisao Banno, who says: "Silicon nitride has higher shock resistance than silicon carbide—and greater strength at up to 900 degrees C (1,652 F). But as with all ceramics, the problem is: How do we guarantee durability?"

Banno thinks the answer may be found in the manufacturing method. The basic process of making ceramic parts is to squeeze powder to the desired shape—a preform—and then to heat it in an oven so it's sintered into a strong, solid component. The problem is that pores develop during sintering. The solution: Pressurize the preform while it's sintered. This is called gas sintering.

"We sinter the parts in a furnace at a pressure of 200 atmospheres (2,938 psi)," explains Banno. The gas in the chamber is nitrogen and the technique can be used to produce strong parts of complex shapes. "We are still developing the process," he added, almost apologetically. "Once we get it refined, though, we'll be able to produce many ceramic parts easily in great quantities."

Competing with NGK Spark Plug and Kyoto Ceramic and their silicon nitride is NGK Insulators and its ceramic of choice, zirconia. NGK Insulators is working with Cummins Engines of Columbus, Ohio, on quite a different concept. Instead of relying on the ceramic to withstand all the mechanical stresses, the company uses the material only as an insulating blanket—the engine structure is cast iron.

This requires a ceramic with some characteristics compatible with cast iron, especially rates of thermal expansion. When heated, both metals and ceramics expand, but metals expand much more. For example, cast iron expands at five times the rate of silicon nitride. If you pushed a silicon nitride cylinder tightly into a cast-iron sleeve, then heated the assembly, the cylinder might drop out.

NGK Insulators has developed a special version of zirconia called "partially stabilized zirconia," or psz. Its rate of thermal expansion is 80 percent that of iron, and it insulates better than silicon nitride. If it fits tightly in cast iron when cold, it remains that way when hot.

The company expects to be able to supply psz components to engine makers by 1985, and it is talking of producing one million units per year, though it's keeping tight-lipped about the project.

If NGK Insulators' success is so close, why are Kyoto Ceramic and NGK Spark Plug unenthusiastic about zirconia? Says Kyoto Ceramic's Hamano: "Zirconia is a possibility, but its high-temperature strength is not good." NGK Spark Plug's Banno echoes these views, saying that it's not suitable for an all-ceramic engine, which is the aim of his company.

More obstacles

Even if the technical problems of ceramics are overcome, there is another hurdle, which may be partially overcome by new production processes. Says Yoshiteru Hamano, "The main problem with ceramic parts now is the cost. Temperatures of over 1,800 degrees C (3,272 F) are needed for sintering, and there is a lot of grinding required." One bright spot is that less energy is needed to produce ceramics than steel—only 50 to 80 percent as much. But even if all the manufacturing difficulties can be overcome, Hamano concedes that lubrication at high temperatures is a "very severe problem that is yet unsolved."

What do Japan's engine makers think of the future of ceramics? Nobuhiko Kawamoto, head of research and development at Honda, is scathingly cynical. "We have tested many parts," he says, "but the engine seizes up long before it is possible to do any real durability work." He thinks that ceramics are likely to be used in piston engines only for specialized parts.

And Ryoji Kihara, director of research and development at Isuzu Motors, is not optimistic either, even though Isuzu is involved with Kyoto Ceramic in a project to develop ceramic engine parts.

In the short term, however, the hybrid metal-psz engine under development by NGK Insulators and Cummins looks like a good bet for a ceramic diesel. PS

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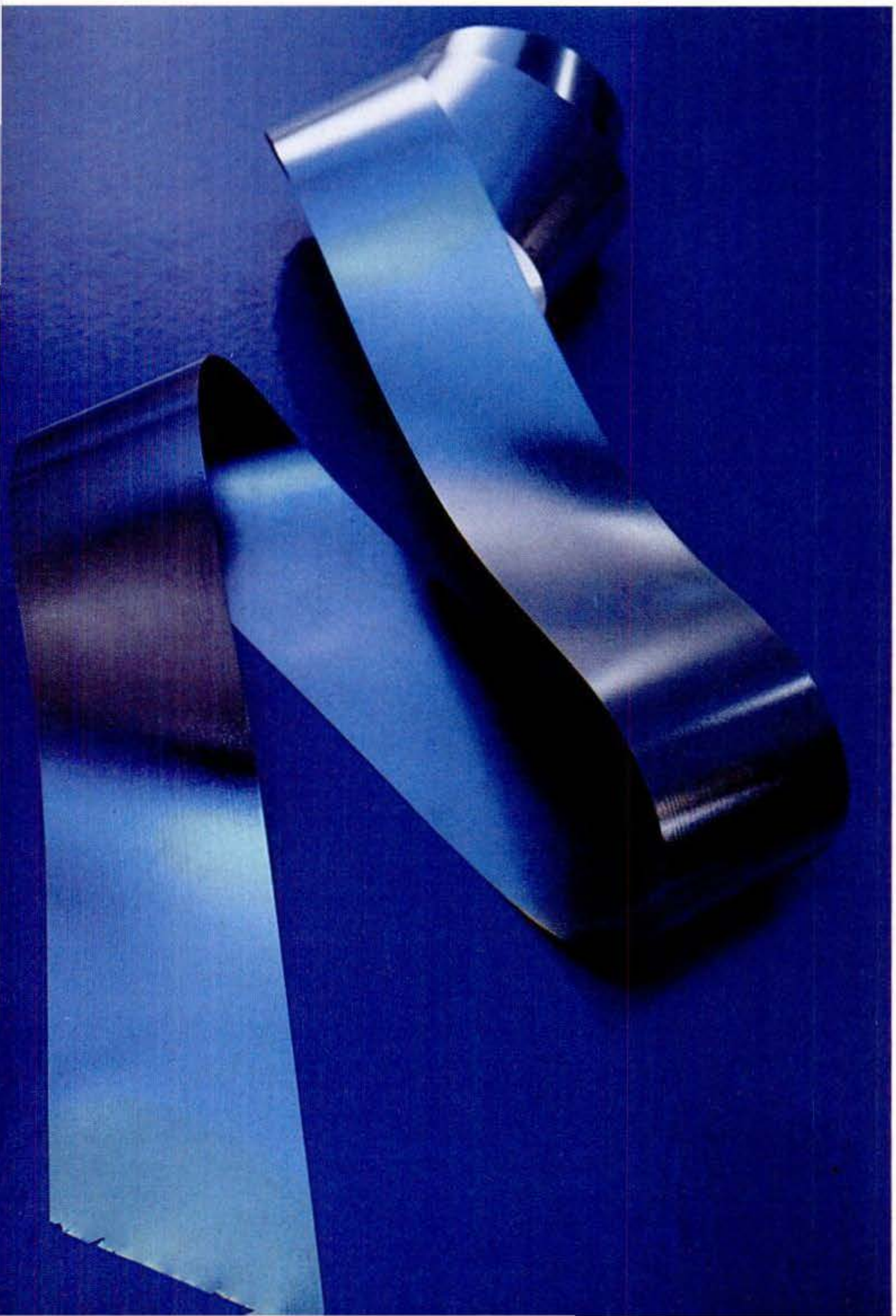
Metal magic

creates glassy steel with strange magnetic ability



Ultra-fast cooling is the secret of a process that could save $1 billion

By CHARLES A. MILLER

At a closely guarded building on the outskirts of Parsippany, N.J., a dazzling feat of modern metal technology takes place. White-coated technicians direct a stream of glowing, molten metal onto a rapidly spinning drum.

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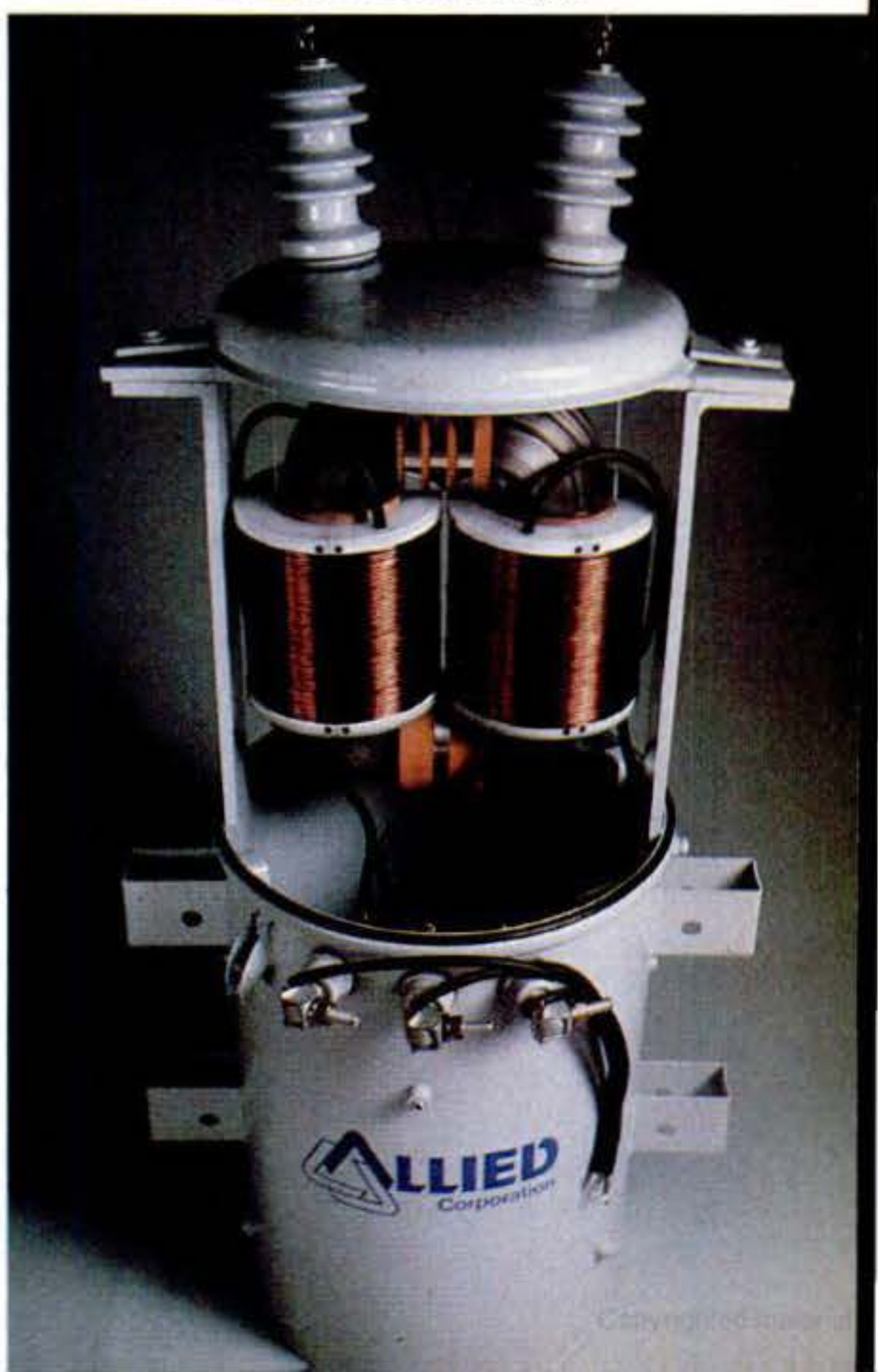
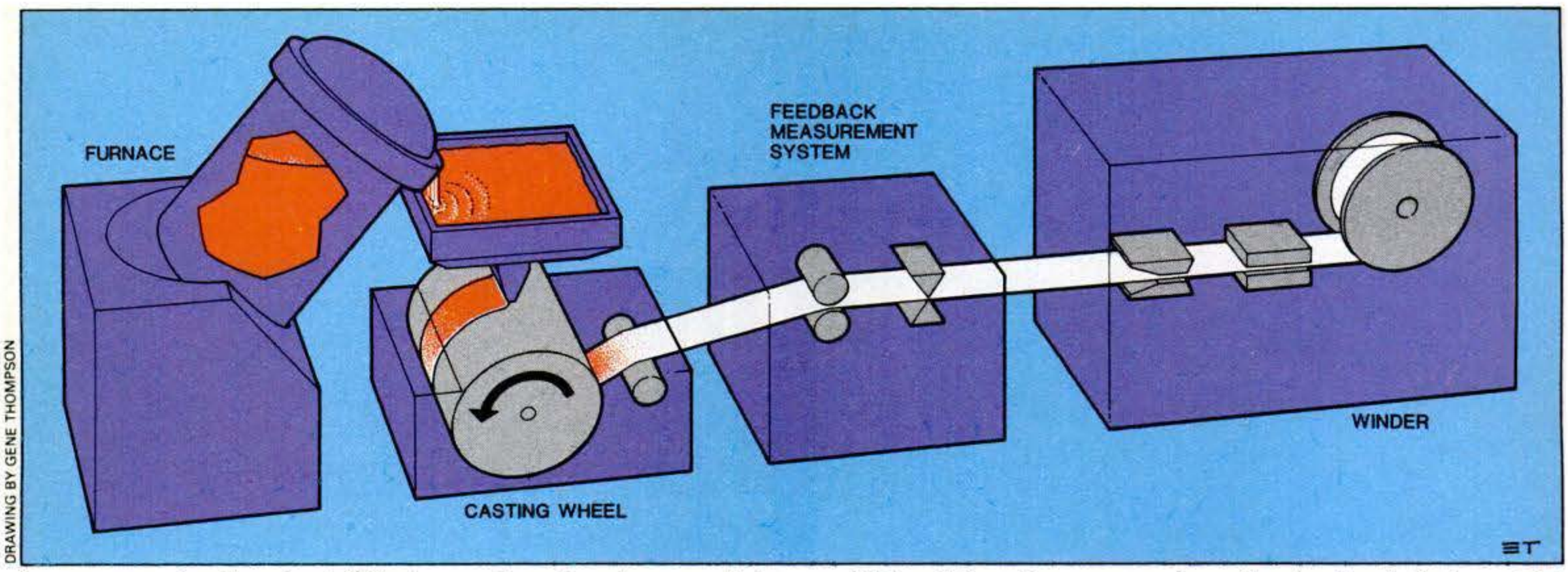
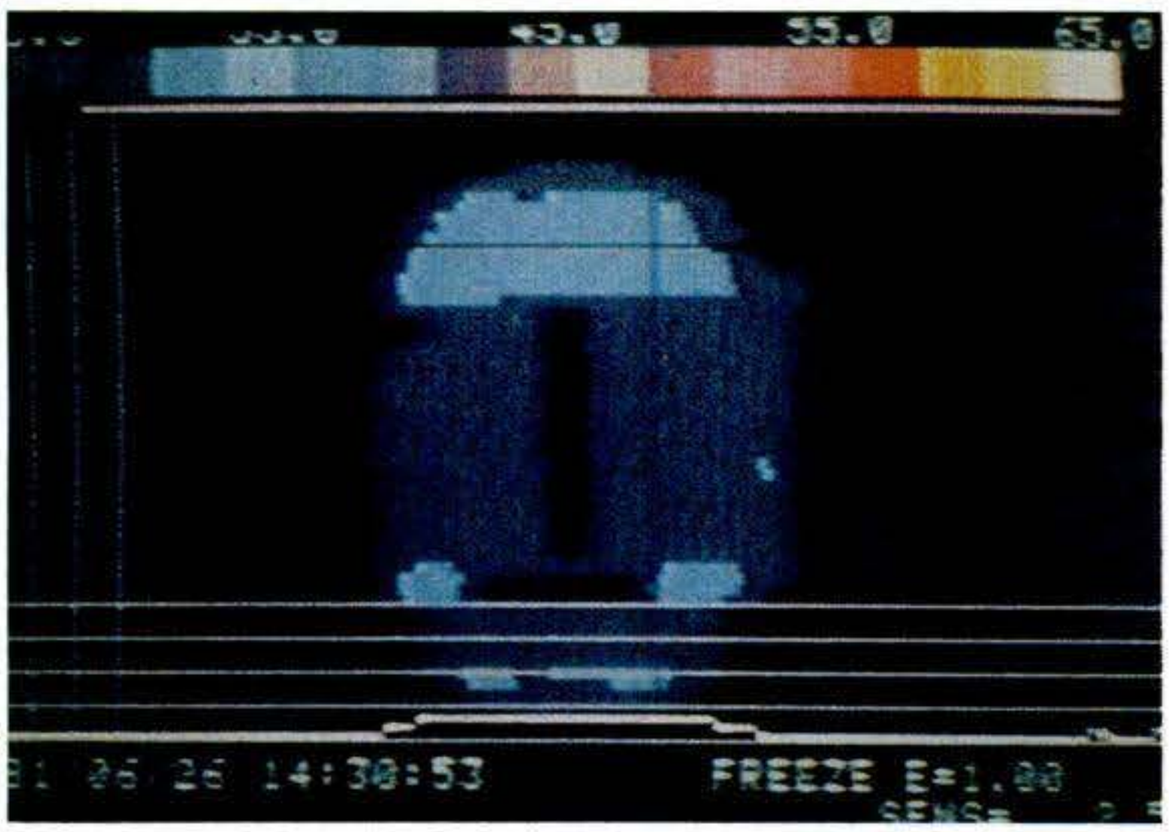
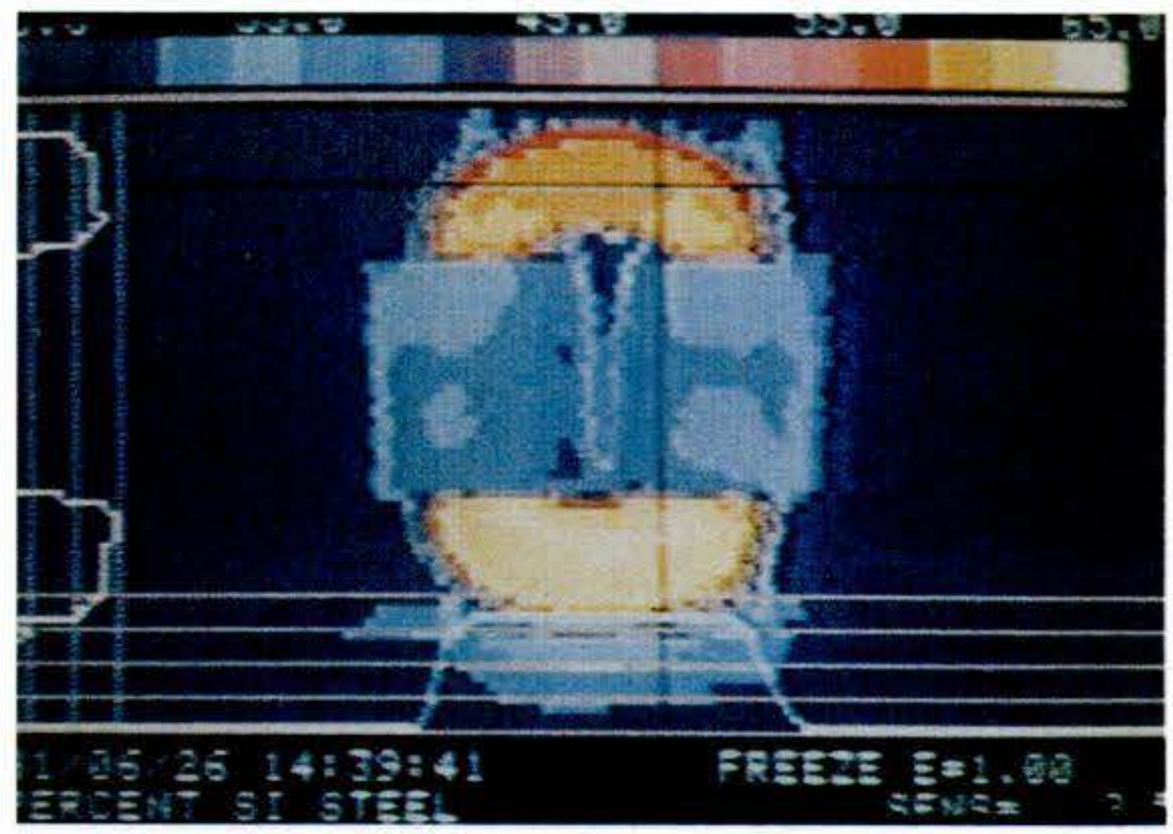
Amorphous alloy (left) is cast in continuous strips one to two mils thick. Its unique magnetic properties can cut core losses in distribution transformers (below).





In process developed at Allied, pre-alloyed molten steel is poured from induction furnace into feeder. Material is projected onto a rapidly spinning wheel, where it solidifies in one millisecond. The ribbon then passes through a feedback device, which monitors the strip and sends data to the casting-head controller. It then goes to winder to be packaged on spools for shipping.





Thermograph shows cool operation of Metglas transformer core (left). Energy losses are dissipated as heat in regular transformer (right). Metglas's core needs less energy to stay excited, thus may reduce annual distribution costs by $1 billion.

The metal cools at a rate of a million degrees per second. What spins off the bottom of the drum at upwards of 50 mph is a narrow, ultra-thin strip looking like shiny aluminized-mylar foil. It's actually a noncrystalline steel, one of a revolutionary new breed of materials called amorphous metals, or metallic glasses.

Unlike conventional metals, which have an organized crystalline structure, amorphous metals have extraordinary properties that could:

- Make transformers more efficient and so improve the distribution of electricity, with savings of more than $1 billion per year nationwide.
- Improve the quality of electronic devices such as tape-recorder heads.
- Increase efficiency of motors by reducing power losses in stators and rotors.
- Improve knock sensors in automobiles, thus leading to better fuel economy.
- Enhance brazing foils for better turbine-blade fabrication.
- Improve the performance of high-energy particle accelerators.

All this from a new kind of steel? That's the consensus I found in talking to research scientists from all across the country. Listen to Dr. J. C. Williams, professor of metallurgical engineering and materials science at Carnegie-Mellon University: "This [process] opens up a whole new set of dimensions in materials science, the limits of which are the imaginations of the people working with the advanced technology."

The world's prime supplier of amorphous alloys is Allied Corp., which makes Metglas, a product used in an increasing number of high-technology products. At Allied's Parsippany plant I met with Don Raskin, who is group manager of Metglas-products applications.

"A number of devices have been made using the amorphous metals produced at Allied," Raskin said, "including prototype transformers built by General Electric, Westinghouse, and others. That's a kind of milestone for us. We've been trying to get the rest of the world to believe that our material is as good as we think. There had been a lot of laboratory-scale work that showed the promise of the material, but it wasn't until transformers were built that people really became convinced. The problem was mainly, 'Well, it works in a laboratory, but does it scale up?' The answer is yes, it does."

How is an amorphous metal made? Most methods involve bringing molten material into contact with a rapidly moving—and cooler—substrate, which does not have to be very cold. Speed is the key: The rate at which the molten material solidifies must be faster than the rate at which it crystallizes.

As Raskin explained, "At cooling rates of about a million degrees a second—starting with material at about a thousand degrees—you have a millisecond to do all your work. That's why these materials don't appear in nature." And that's why amorphous metals don't have the crystalline subatomic order common to all ordinary

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metals—they're cooled from liquid form so quickly that their atoms don't have time to rearrange themselves. The random structure of the molten state, in effect, is frozen in during solidification.

The alloy, in ribbon form, is very thin, on average about one mil or so. If it were thicker, there would be no way to quickly get the heat out of its center—the desired properties would not be uniform throughout.

Amorphous alloys are also quite abrasive. Ed Norton, a project manager at the Electrical Power Research Institute, sponsor of applied research on amorphous metals, gave me an example: "A normal carbide die on a punch would last about a half million operations with silicon iron. The same die used on an amorphous-metal alloy sheet would last only about 1,000 operations."

Where the amorphous alloys—those with iron in the mix—really shine is in electromagnetic devices. Ferrous amorphous alloys are "soft" magnetic materials, meaning they're very easily magnetized and demagnetized. In fact, they may be the "softest" magnetic materials in existence.

At Westinghouse, Harry Sheppard, manager of materials and manufacturing technology, explained: "In a crystalline ferromagnetic material, the easy direction of magnetization depends on the orientation of crystals. So if there is no orientation of crystals, as in amorphous metals, then there is no one easy direction of magnetization," meaning that all directions are similar. Practically speaking, the magnetic flux doesn't have to fight as hard (use as much energy) to overcome the resistance to its flow when changing direction.

That's significant, especially when designing such electrical devices as transformers. In the process of making a voltage change, the core of a typical transformer is magnetized and demagnetized 120 times a second. Because of this, there are electrical losses from hysteresis, eddy currents, and other less-understood phenomena, given off as heat.

Generally speaking, the total losses in modern transformers are less than two percent, which may not seem prodigal. But in a typical electrical-distribution system, where there may be four transformations of voltages, there is a two percent loss with each change. The more times it's necessary to transform voltages to get power from a generator to the end user, the more power is lost. With 40 million distribution transformers in use today, losses nationwide add up to billions of kilowatt-hours.

Said Allied's Don Raskin: "Just in distribution transformers, the losses in the transformer steel now used are estimated at 30 billion kilowatt-hours annually. If amorphous alloys were used, two-thirds to three-quarters of that loss could be prevented."

Making a transformer with amorphous metals is not without problems, however. "The material is substantially different from what both our design engineers and our factory technicians are used to," says Dr. Lyman Johnson, head of the amorphous-metal program at General Electric. The silicon steel used today in transformers is around 0.01 or 0.011 inch thick. There have to be seven or eight times as many layers of amorphous metal in a transformer, which brings up questions of handling—how to wind it, cut it, fit it. The material is very strong and hard, but for use in a transformer, it must be annealed. That makes it brittle; it then needs special handling so it doesn't break.

Despite the problems, it's likely that amorphous-metal transformers will play a significant role in America's energy future. According to Ed Norton, "It will take several more years to fully investigate the uses of amorphous metals, but I expect to see transformers of amorphous metals on poles by 1989. And substation transformers could come sooner—by 1986."

Widespread uses

Amorphous metals have many other applications, as well:

- Brazing alloys are generally powdered nickel-base compounds, which have such problems as binder burn-off and shrinkage, plus possible joint contamination. Allied's process makes brazing foil in one step from a liquid, so there are no powdering steps, no binders—and the foil is ductile (normally, nickel-base brazing alloys are brittle). The foils also offer better corrosion resistance and mechanical properties.
- Amorphous metals make excellent high-power switches. Imagine what would happen to your light switch if it had to handle a few million volts—or more. Turning on and off giant electrical pulses is one of the problems faced by designers of particle accelerators. Amorphous metals play a part in extending the life of such power-handling equipment by eliminating physical contacts. Magnetic switches control the huge currents in a pulse-forming network by holding off a pulse until the core saturates, then allowing the pulse to pass. There are no physical contacts or arcing elements, so equipment lasts longer.
- Amorphous metals can contribute to automotive fuel economy, too, because they make good knock sensors. Some of the amorphous materials convert mechanical energy to electromagnetic energy more efficiently than any other material, including piezoelectric crystals. As vibration sensors, they're rugged, sensitive, simple, and ultimately cheap. The idea, developed in part by GM, works this way: An amorphous-metal sensor bolts onto the side of an engine. The sensor is designed to recognize a specific frequency, that of engine knock. When it "hears" that frequency, the sensor generates a voltage in a coil surrounding it. The signal feeds into an on-board computer that retards the engine timing.
- A new experimental thermal window shade uses a thin amorphous-metal ribbon on its edges to hold it against magnets taped along the window trim. Why use an amorphous metal? There are no other "soft" magnetic materials with good mechanical properties. If bent, a good nickel-iron stays bent—it doesn't spring back. An amorphous metal can be made so that if it's folded over on itself, just short of creasing, it will spring back to its original shape.
- TDK, licensed by Allied, sells amorphous-metal recording heads for tape decks. These heads pick up and play back with more clarity than Permalloy or other types of magnetic heads, thanks to a minimum of magnetic distortion.
- Amorphous-metal applications may show up, too, in electric motors, for rotor and stator cores, where energy savings could be even more dramatic than in transformers. Emerson Electric is investigating the use of amorphous metals in motors, though the mechanical hardness of the material could make a breakthrough difficult to achieve. Again, cutting the material wears out dies very quickly, so a way must be found to cast it directly in the desired form. But it's worth the quest: In some cases, the cost of operating some large industrial motors could potentially be reduced by $1,000 a year.

Allied has been able to lower the price of amorphous metals drastically in a short time. In 1978, it sold research quantities for about $300 a kilogram. Early this year the price was $20 a kilogram, in volume. Allied expects the cost to come down to $4 in the near future, which is necessary if amorphous metals are to compete with other materials. That works out, considering production runs measured in miles, to about a penny a foot. PS

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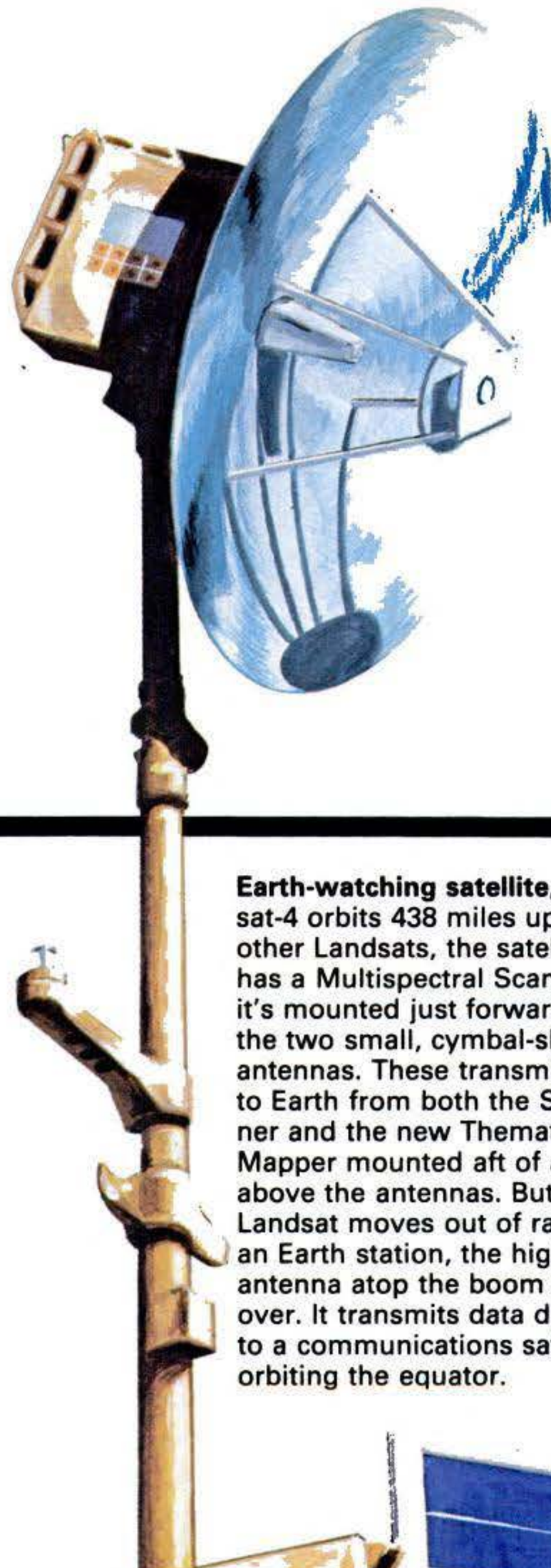
New eye in space: Landsat-4



New high-resolution images and high-speed data transmission reveal the Earth's hidden riches

By DICK YOST
ILLUSTRATIONS: GE SPACE CENTER

Of all the rugged cliffs in the Rockies, which ones hold secret stores of gold-bearing ore? And of all the flat plains in Texas, which ones conceal pools of oil? To answer these questions, prospectors and wildcatters once labored across the West, laden with tools and supplies. Today's treasure hunters have a new tool—a sharp-eyed satellite called Landsat-4.

Orbiting Earth from pole to pole, the satellite transmits detailed images of the terrain it passes over. It can produce a 13,225-square-mile (34,225 km^2) view of practically any spot on Earth.

Continued

Earth-watching satellite, Landsat-4 orbits 438 miles up. Like other Landsats, the satellite has a Multispectral Scanner; it's mounted just forward of the two small, cymbal-shaped antennas. These transmit data to Earth from both the Scanner and the new Thematic Mapper mounted aft of and above the antennas. But when Landsat moves out of range of an Earth station, the high-gain antenna atop the boom takes over. It transmits data directly to a communications satellite orbiting the equator.

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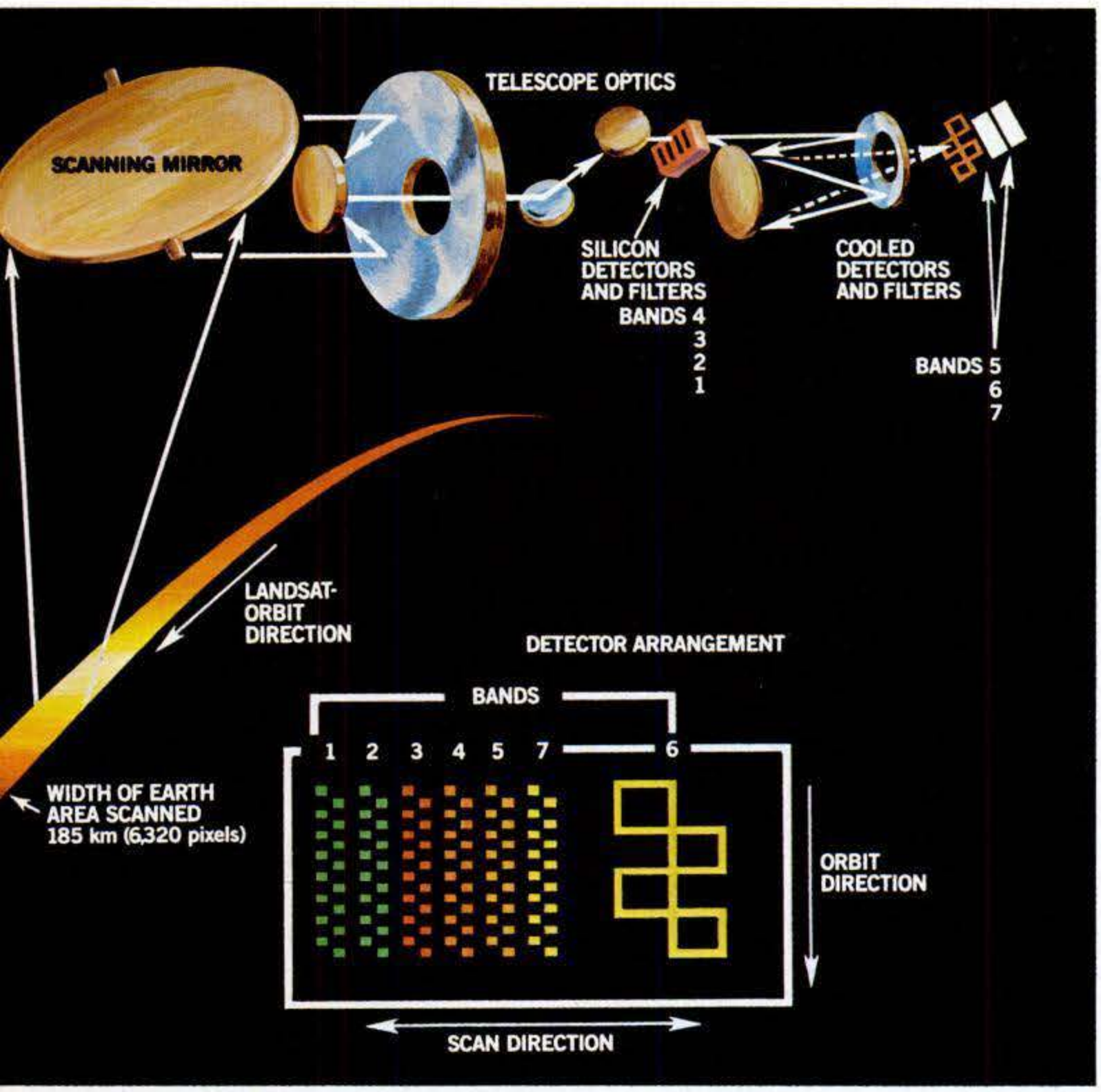
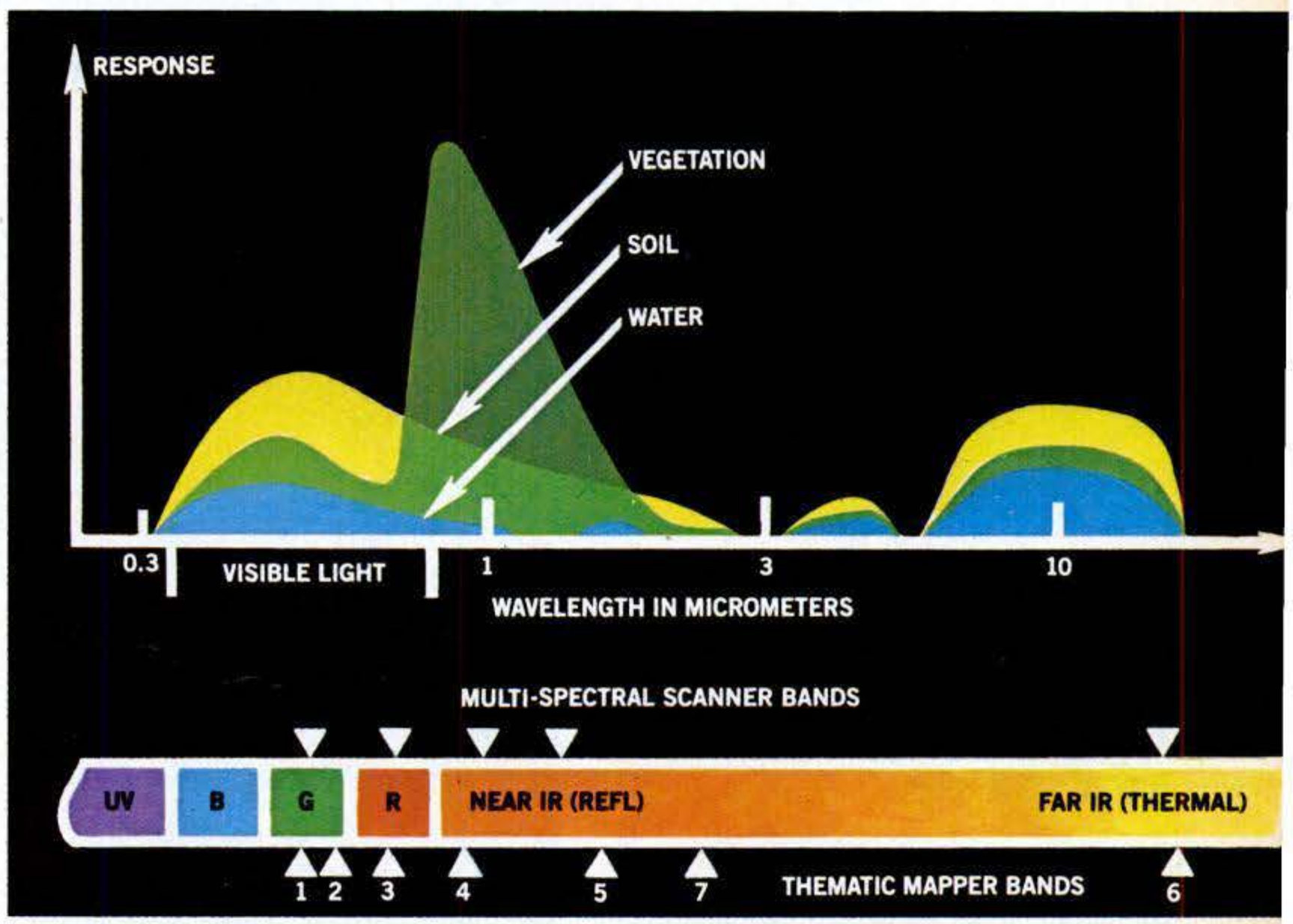


Gathering Earth light, the Thematic Mapper's scanning mirror flashes images from points spanning a wide ribbon of Earth. The images are beamed through a telescope and relay mirrors onto filters for each set of wavelengths or spectral band scanned. Each filter is backed by an array of photodetectors that measures the intensity of the reflected light. Since there are 16 detectors for each (except for band 6, which has a lower resolution), the oscillating mirror scans 16 lines in one seven-second sweep. The detectors "see" each line as a series of points or pixels. Each pixel represents the total light reflected from an area 30 meters (about 98 feet) across. Landsat images transmitted by the Thematic Mapper contain 300 million pixels—the Multispectral Scanner, with coarser resolution, transmits only 32 million. The new instrument also has greater sensitivity. Pixels in a Thematic Mapper image represent 256 brightness levels, compared with 64 levels in a Multispectral Scanner image. Computers translate these brightness levels, or shades of gray, into rich shades of color that better reveal landscape details.



Plants, soil, and water respond to sunlight in different ways, each absorbing some wavelengths and reflecting others with varying intensity. Landsat's scanners identify objects by these patterns. Healthy vegetation, for example, is revealed by the green detector on the Multispectral Scanner (spectra diagram), which picks up light in the 0.5–0.6 range. The Thematic Mapper has two detectors for this range, so it can identify a variety of similar plants. Mapper band 5 separates clouds from snow. It also measures plant moisture, so reveals drought damage. Band 7 (a latecomer added for geologists) detects deposits of mineral-rich clays. Band 6 is only one that doesn't monitor reflected sunlight. It detects heat emitted directly by objects, so can identify "feverish" plants and other heat sources.

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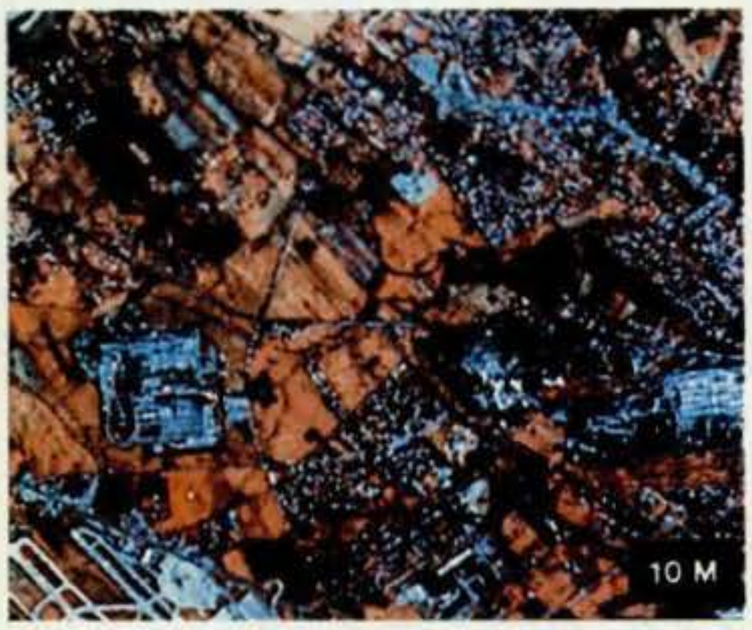

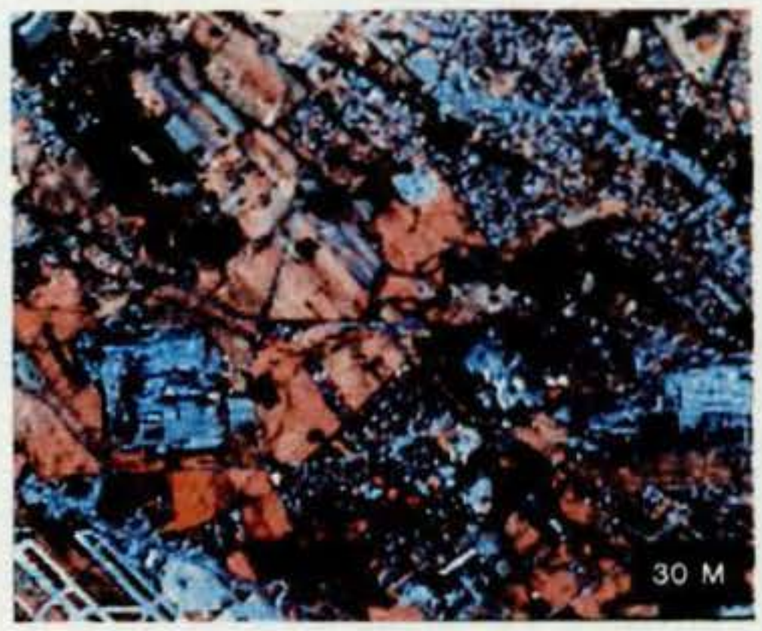

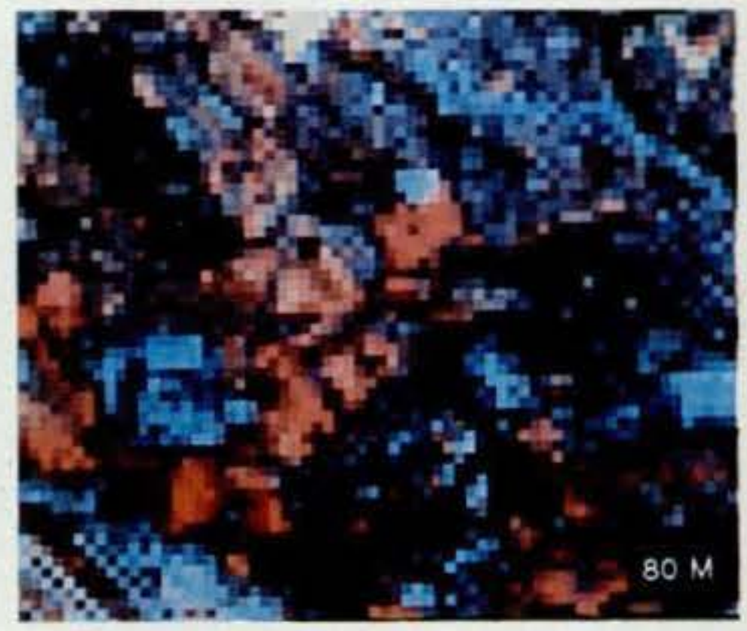

Streets of Detroit crosshatch the city (top) and sediment swirls along its shores in this image transmitted by the Thematic Mapper aboard Landsat-4. Three views of Maryville, Tenn. (above, taken by a simulator aboard a research plane), dramatize the differences in resolution. At 80 meters (right)—the resolution of the Multispectral Scanner—the city looks like a rough mosaic. Thirty meters (the Thematic Mapper's resolution) sharpens the focus, revealing the street grid—a boon for urban planners. Super-sharp images with 10-meter resolution will be sent by France's SPOT satellite, planned for orbit in the late 1980's.

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The first Landsat, launched in 1972, was called ERTS, for Earth Resource and Technology Satellite [PS, Feb. '74]. Two more satellites were orbited (in '75 and '78), and the name was changed to the more euphonic "Landsat."

Over the decade, a multimillion-dollar industry evolved among users of Landsat data. To upgrade the system, a fourth Landsat was launched last July 16. But unlike earlier versions, the new satellite carries two different imaging instruments.

One imager, the Multispectral Scanner, will keep the steady stream of regular Landsat data flowing to resource managers around the world. The second instrument is making its test flight. This advanced scanner is called the Thematic Mapper because it can produce "theme maps" highlighting farms, forests, or mineral resources of an area.

The Thematic Mapper makes Landsat-4 even more useful than earlier resource satellites. Already, Landsat-4 is transmitting sharper, more detailed images. The new satellite can also "see" more than its predecessors. It should reveal previously hidden, or at least hard-to-find, resources—such as oil, gas, and precious minerals. And Landsat-4 will deliver this sought-after data faster than earlier satellites could.

Recording reflected light

Landsat imagers collect light energy reflected from Earth directly beneath the satellite. Breaking the scene below into millions of points, the imagers measure the brightness of each point. Landsat's electronics convert these brightness points (called pixels, or picture elements) into digital data for transmission to Earth.

Reproducing an array of pixels generates a light-dark image of a large patch of Earth. Computer processing translates the image into a many-hued picture. But the colors are surprising. A Landsat image looks nothing like Earth photos taken by shuttle astronauts.

Because Landsat passes the Earth light through filters, the final image is multispectral—it shows the scene as it appears at different wavelengths. What's the use of this?

When sunlight hits an object, some wavelengths are absorbed and others are bounced back. The object's chemical makeup determines what spectra are reflected. We call this reflected light "color," of course, but our eyes can't discriminate the subtle differences among all the wavelengths reflected.

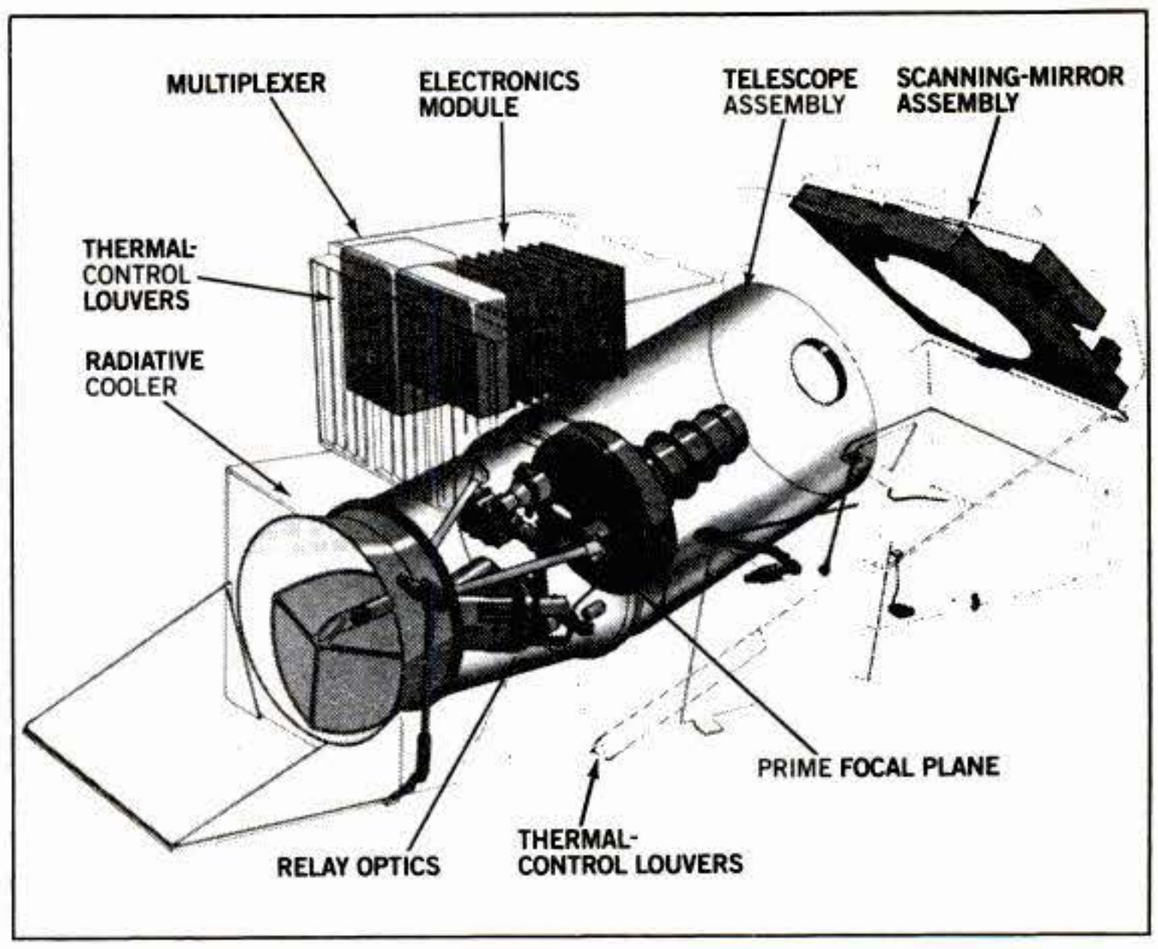
Landsat can. Its imagers sort out the "spectral signatures" of different Earth features—soil, water, and varying types of plants. Since the imagers can detect many more wavelengths than we can, Landsat produces a picture of Earth not even the keenest eye could see.

If we could "see" in infrared, for example, forests would be tomato-colored. That's because chlorophyll has a much brighter reflectance peak in the near infrared than it does in the green wavelength of visible light. And if we could see in the thermal infrared band, we could pick out diseased trees in the forest. (Plants get fevers too.)

A versatile view

The Multispectral Scanner detects four spectral bands sensitive to variations in plant chlorophyll and plant biomass. Such data are useful for monitoring land use.

But the new Thematic Mapper detects seven spectral bands (see diagram). The extra bands provide more information. The Mapper is sensitive not only to vegetation—it can also identify some minerals. It can tell the difference between ordinary dirt and clay with a high mineral content. Such clays often signal the presence of valuable minerals. The Mapper will also be able to discriminate between clouds and ground snow cover—a key distinction for crop forecasters.



A powerful sensor, the Thematic Mapper focuses reflected light through high-resolution optics (see previous diagram). The sensor is mounted on the Landsat satellite so the radiative cooler faces outward to deep space. Detectors for three infrared spectral bands are housed in an insulated container attached to the cooler. The other detectors are mounted at the prime focal plane. The electronics module converts the light energy registered by each detector to digital signals for transmission to Earth.

And though four of the Mapper's bands are similar to those detected by the Scanner, the Mapper's bands are narrower. They can detect finer differences between light reflected by related objects. Where the Scanner can distinguish between pine forests and hardwood ones, for example, the Mapper will show different species of pine.

The Thematic Mapper also produces images with a sharper resolution than older scanners. Each pixel in an image produced by the Multispectral Scanner represents an area of about 262 feet (80 meters). With this resolution, the Scanner can pick out fields about 40 acres in size. That's like being able to see New York's Shea Stadium from downtown Detroit. By contrast, the Mapper has a resolution of about 98 feet (30 meters). Each pixel stands for an area the size of a baseball diamond. This improved resolution should increase accuracy in identifying small fields and forest stands down to about 10 acres.

The clearer views the Mapper transmits will also get to users faster than data from earlier Landsats. Among the major weaknesses of the earlier Landsats were the tape recorders used to save data when the satellite was out of an Earth station's range. Too often, the recorders failed.

Landsat-4 has no tape recorders aboard. Instead, data will be beamed directly to one of two Tracking and Data Relay satellites [PS, March '78]. Stationed in geosynchronous orbit, these satellites can instantly retransmit the data to a ground station at White Sands, N.M. From there the data will be retransmitted, via a domestic-communications satellite, to the main receiving station at Goddard Space Flight Center in Maryland.

Previously, it took weeks for users to acquire data. With the new system, it will take several days.

The first Tracking and Data Relay satellite will be launched next January aboard the shuttle. Until then, Goddard researchers will work with limited amounts of Mapper data. They'll start processing 200 Scanner scenes and one Thematic Mapper scene a day. By 1985, researchers hope to process 100 Mapper scenes a day.

Landsat transmits these scenes at a rapid 85 megabits per second (compared with 15 for the Scanner). The researchers just hope their computers can keep up with the fast-changing views sent by our new eye in space. PS

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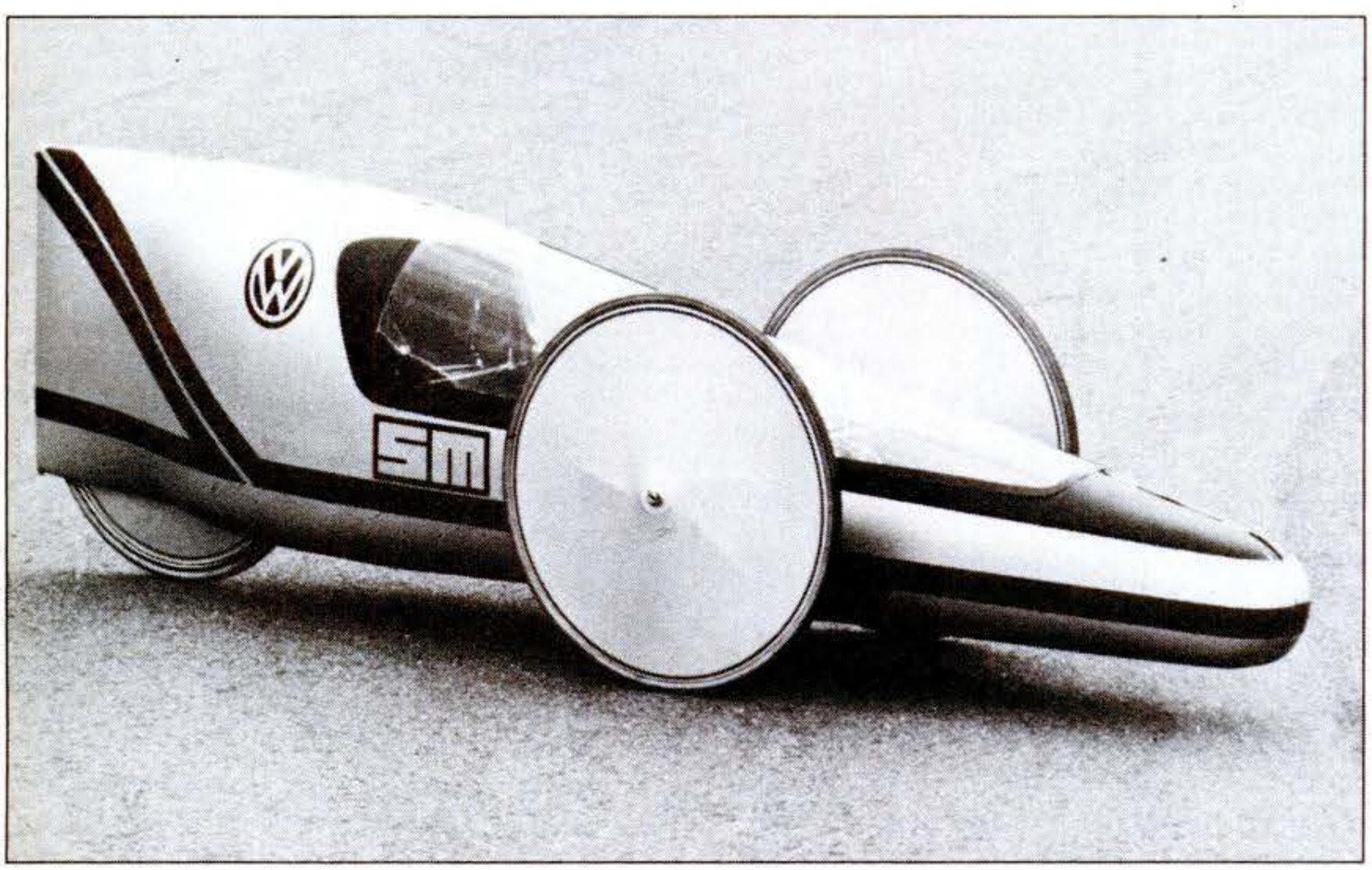
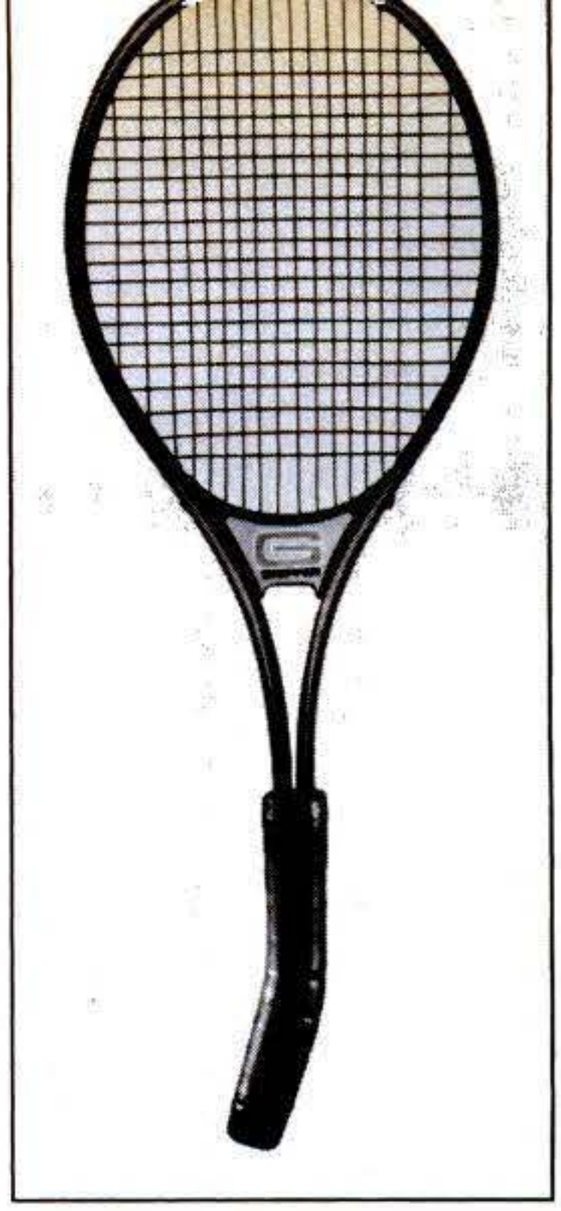
What's New

A PICTURE ROUNDUP OF NEW PRODUCTS AND DEVELOPMENTS





Bent handle

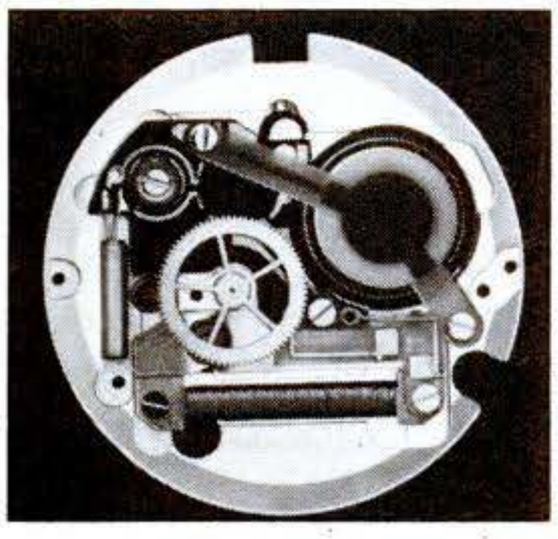
Developing tennis elbow? A unique 19-degree bend in the Gripper racket handle can dramatically reduce ball-contact shock, and needs about 80 percent less grip pressure, claims CCS Products, 2401 Plum Grove Rd., Suite 200, Palatine, Ill. 60067.

2,081-mpg VW

Top prize in a recent German mileage marathon went to a 63-pound Volkswagen entry, the Economymobile. Driven by a 91-pound VW secretary, the vehicle achieved 2,081 mpg. The car, with an ultra-low 0.15 drag factor, is powered by a 25-cc direct-injection diesel.

Engineering copier

Xerox's new 2020 copier handles engineering or architectural drawings up to 24 by 36 inches. The copier offers size-for-size printing, half-size reductions, and 63 percent reduction that shrinks 22-by-34-inch originals to 14 by 22 inches. Price: $17,750, or about $335 a month rent.



Ball-bearing quartz

Shown several times actual size, Mat-Tech II is the first watch movement to combine quartz electronics with precision ball bearings at key pivot points, says Johnson Matthey Time (50 Vision Blvd., E. Providence, R.I. 02914). New platinum watches cost $1,500 to $15,000.

Quick-turn F-16

Unusual mini-wing flight-control surfaces, located below the cockpit of this experimental F-16, enable it to make fast flat turns without banking. The twin canards, with other control surfaces, enable the fighter to turn and fire at targets quickly.

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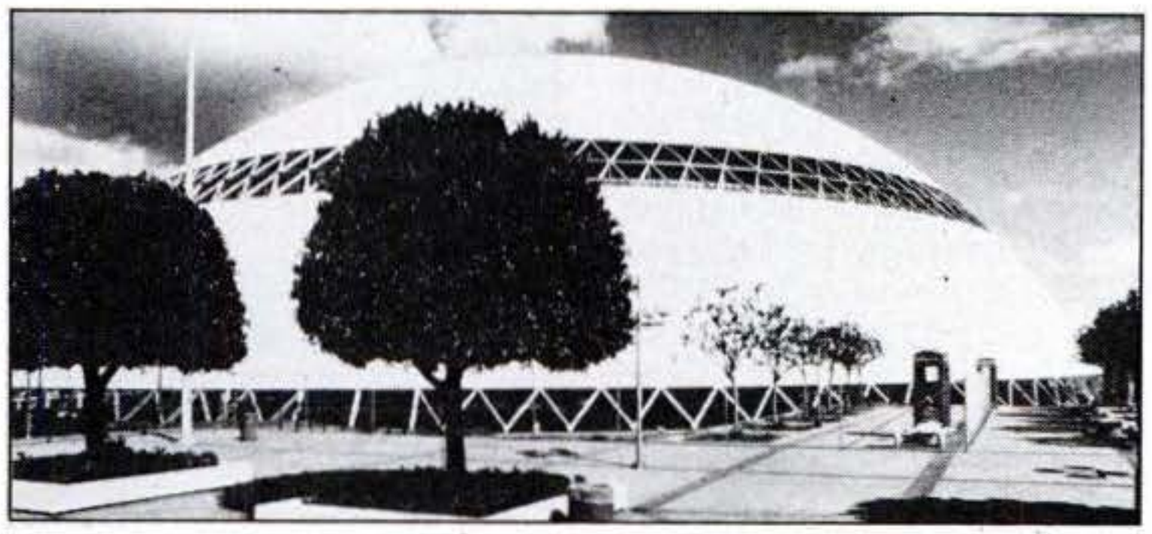
Jet-launched spacecraft

A reusable spacecraft that is launched from atop a modified 747, then propels itself into orbit, and lands like a glider? It's feasible by 1988, says Boeing. The space vehicle could operate with or without a crew. Air Force jetliners could be kept on runway alert.



Giant dome

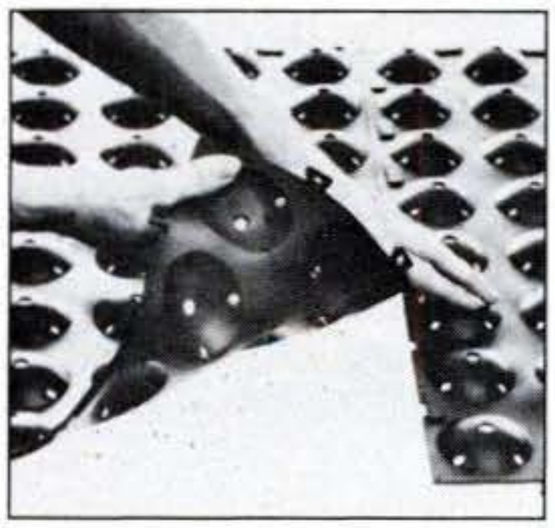
The world's largest clear-span aluminum dome houses the world's largest airplane, the Hughes "Spruce Goose" flying boat. Located in Long Beach, Calif., the PPG Duranor protected dome rises 130 feet and has a base diameter of 415 feet. It will open to the public in July '83.

Kit cabin

Need a low-cost recreational home? Some perspiration and $2,800 give you Wilderness One, a do-it-yourself cabin from a kit. The 12-by-16-foot cabin can be built by two people in four or five days, says Wilderness One, C.T.I., 507 Navarino St., Algoma, Wis. 54201.

Pool heater

No pumps, tubing, or solar panels—Solar 100 Mats just rest on the bottom of your pool, says the maker. Each interlocking mat has 56 semi-spherical plastic chambers that absorb solar energy to heat water. IGN Inc., 71 Ethan Allen Highway, Ridgefield, Conn. 06877.



Concrete collector

Glass-reinforced concrete promises low-cost solar collectors, according to SRI International (Menlo Park, Calif.). The material is cheaper and lighter than metals. And aluminized polyester film can be sprayed on to create a reflective surface.

Ford Sierra

Sleek styling from Ford's Probe III, a 21st century design exercise ["PS Car of the Year 2000," May], has been adopted for the firm's European Sierra hatchback. The rounded shape provides a 0.34 drag coefficient, far lower than today's 0.44 average. The car boasts seven engine options.

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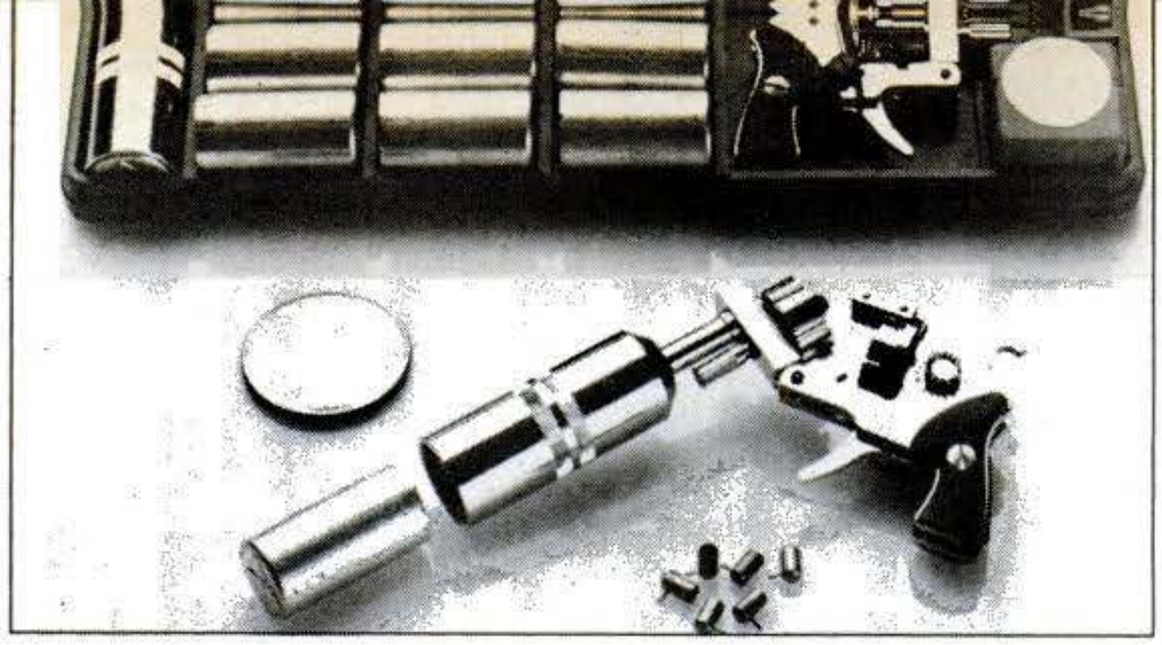
What's New

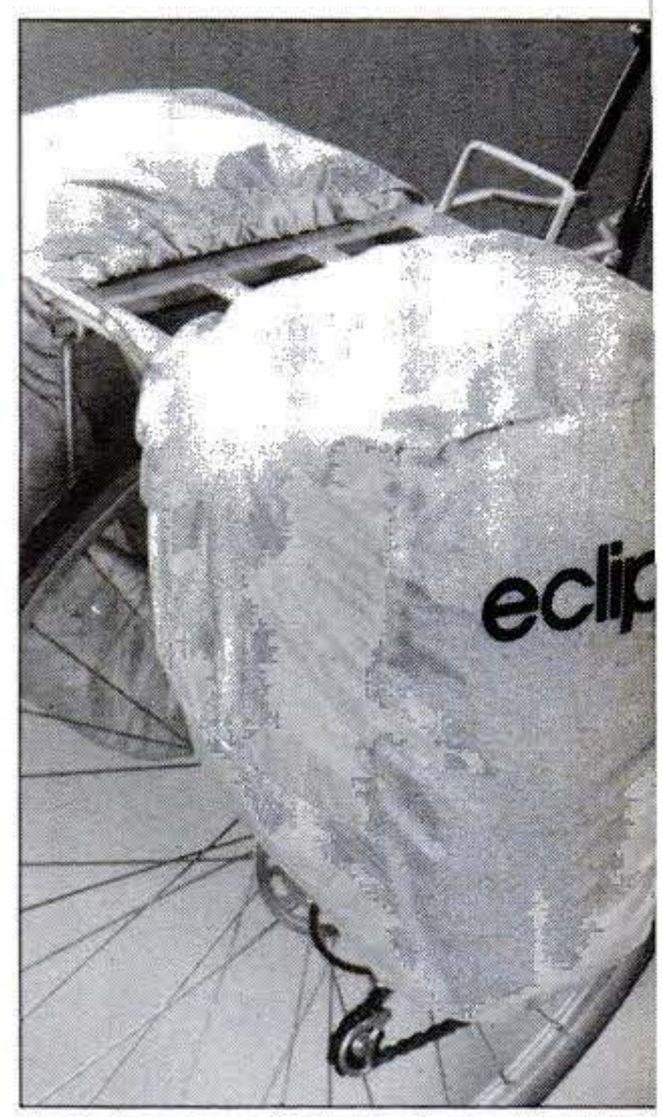


Attention getter

Ten signal flares and a revolver fit into this five-inch-long, crush-proof case. The tiny gun shoots bright-colored flares 70 ft. into the air, says the maker (T&M, 1402 Laurel Avenue, Hollywood, Calif. 90046). The Emergency Signal Kit weighs three ounces, costs $40.

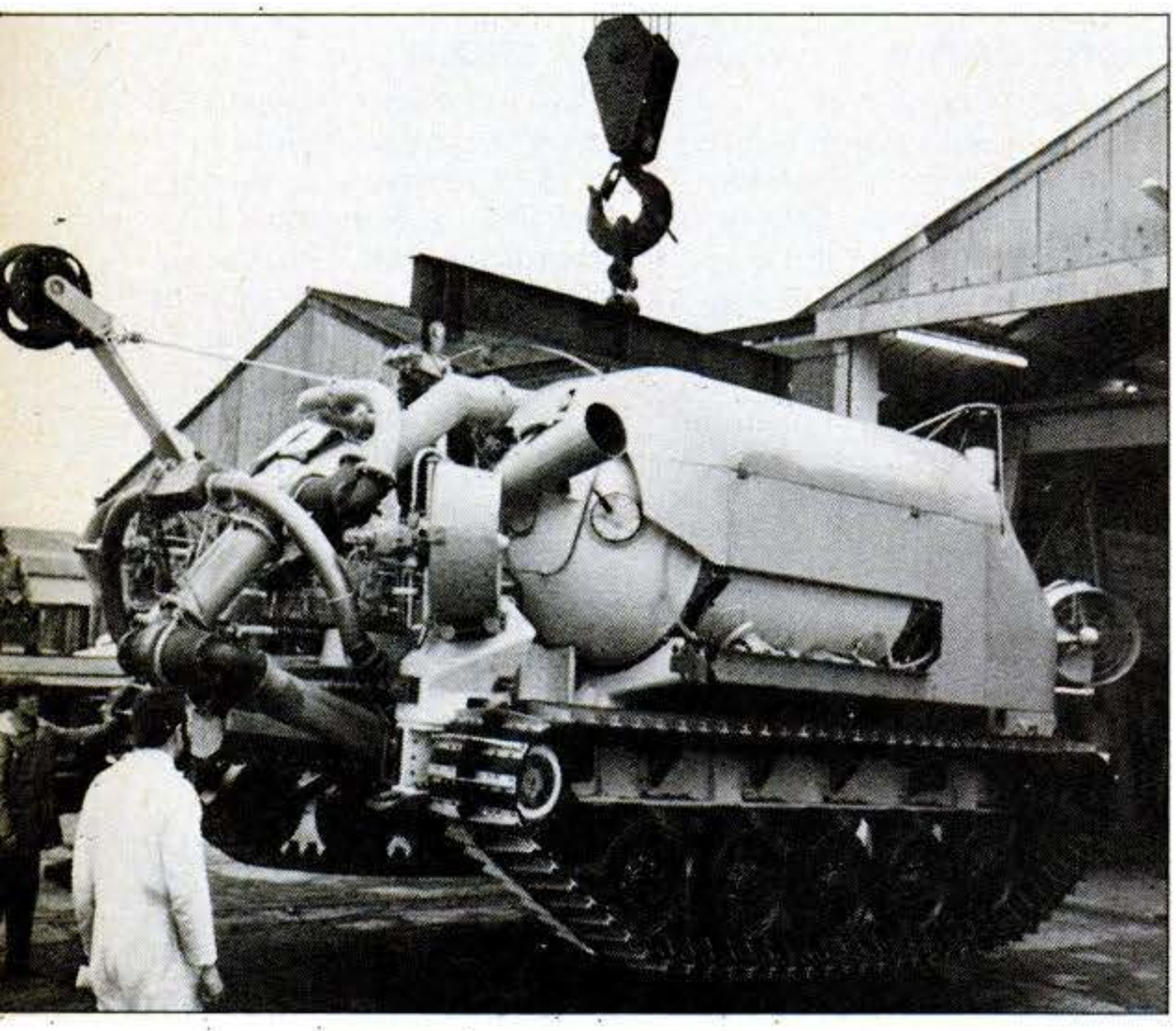
Tandem plane

Updated propellers work with conventional tail jets to power this modified Gulfstream-2 executive jet. Lockheed-Georgia Co. built the research plane for flight tests of NASA's new 10-blade, nine-ft. propfan system [PS, Aug. '81]. It may lower fuel costs for planes in the 1990's.



Pannier protectors

Waterproof bike panniers work until there's a real deluge. Then rain can soak through the seams. Pannier rain covers by Eclipse (Box 7370, Ann Arbor, Mich. 48107) add another protective layer. Both covers fold to fit into one pannier's smallest pocket. Price: $16 a pair.



Undersea crawler

No driver's seat needed—this undersea tractor is remotely controlled. A tether carries TV pictures of the seabed to shipboard operators. Twin-ducted props propel it as it plows trenches in the sea floor. Then hydraulic "hands" lay cable for British Telecom Co.

Solar tracker

Parabolas replace panels in the Solartrac system. Electronically controlled antennas follow the sun, focusing energy onto a receiver. A working fluid transfers heat to water-storage tanks. Dual-axis drive is accurate to ⅛ degree, says Solartrac (Box 670, Beacon, N.Y. 12508). $4,500–$9,000.

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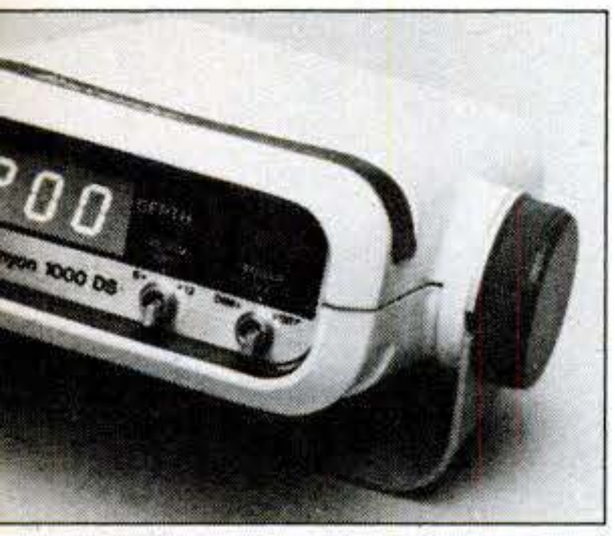
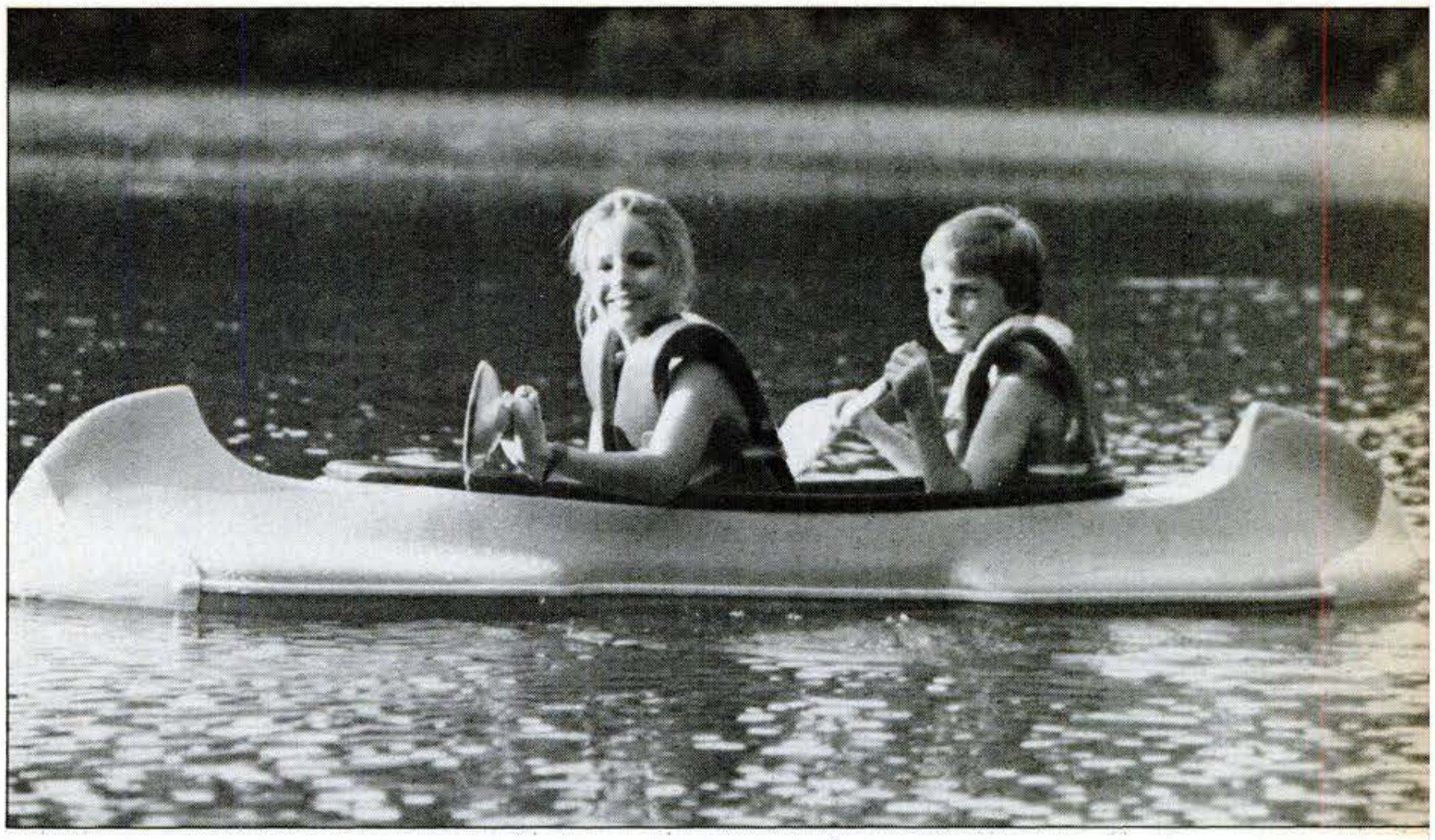
What's New
IN BOATING

BY SUSAN RENNER-SMITH



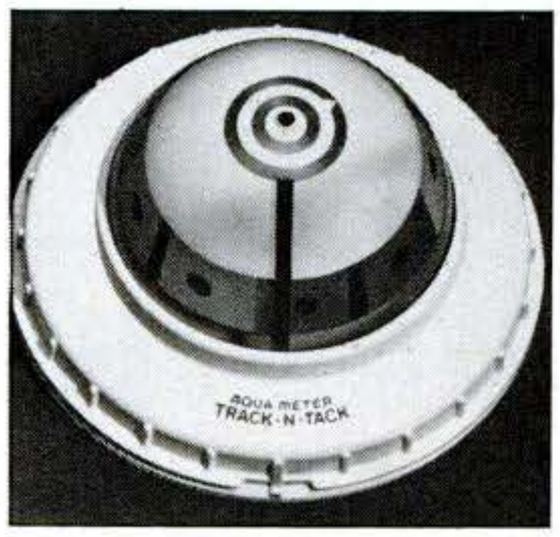


Brilliant sounder

The bright-blue LCD display on this sounder is easy to read even in glaring sunlight, claims Kenyon (Box 308, Guilford, Conn. 06437). The DS-1000 has a range of 300 ft. with audible and visible alarms. These can be preset for a six- or 12-ft. range. An adjustment changes the readout to fathoms or meters.

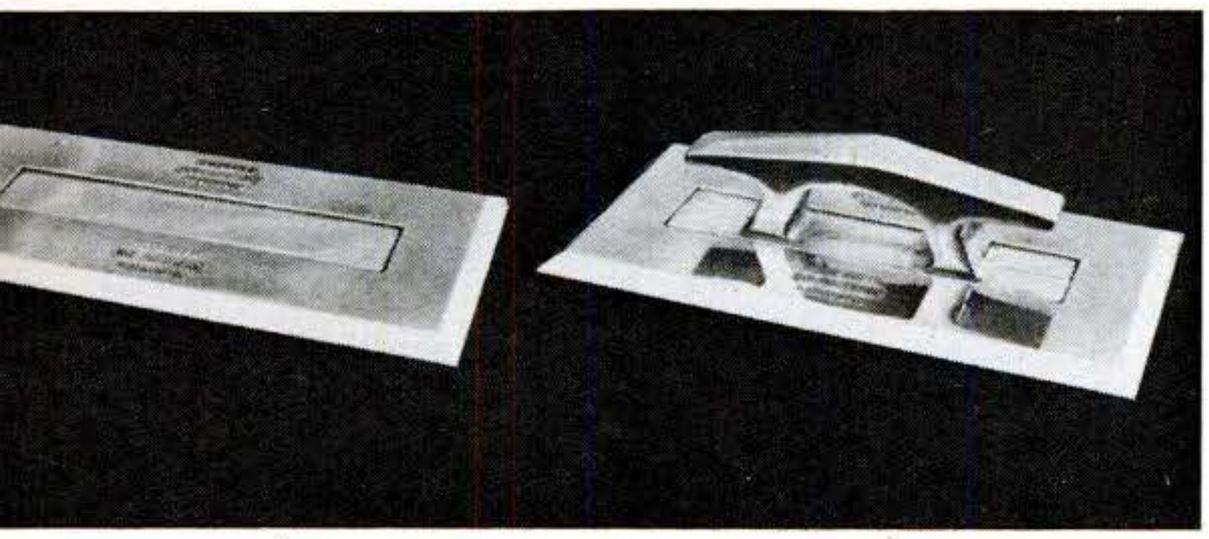
Kid canoe

Designed for easy paddling, this fiberglass trainer has a stern control fin. A water-level sponson adds extra stability. Two sturdy children should be able to portage the 50-lb., 7½-ft. long craft. Price: $350 from Venture-Highlite, R.R. 5, Hwy. 14, Greer, S.C. 29651.



Wind tracker

Windsurfers and Sunfish skippers can sharpen sailing skills with Track-N-Tack. A color-coded display shows the best windward course. The dome-top heel indicator helps find the best angle for downwind tacking. The easily mounted guide costs $34.50. Aqua Meter, 465 Eagle Rock Ave., Roseland, N.J. 07068.



Hideaway cleat

Push-down cleat stays flat till you need it, then pops up on stainless-steel springs. An interlock distributes stresses to the boat. This makes the cleat stronger than conventional ones, says Meacham (7842 Commerce Pl., Sarasota, Fla. 33580). The $80 cleat handles ½-in. line.

Versatile sloop

Cruise offshore, poke about in shallows, or skim along at 12 knots. Innova 26's planing hull, retractable rudder, and six-ft., 1,000-lb. swing keel make it possible, says Innova (Box 124, Croton-on-Hudson, N.Y. 10520). Foam-core construction makes it sink resistant. Price: about $22,000.

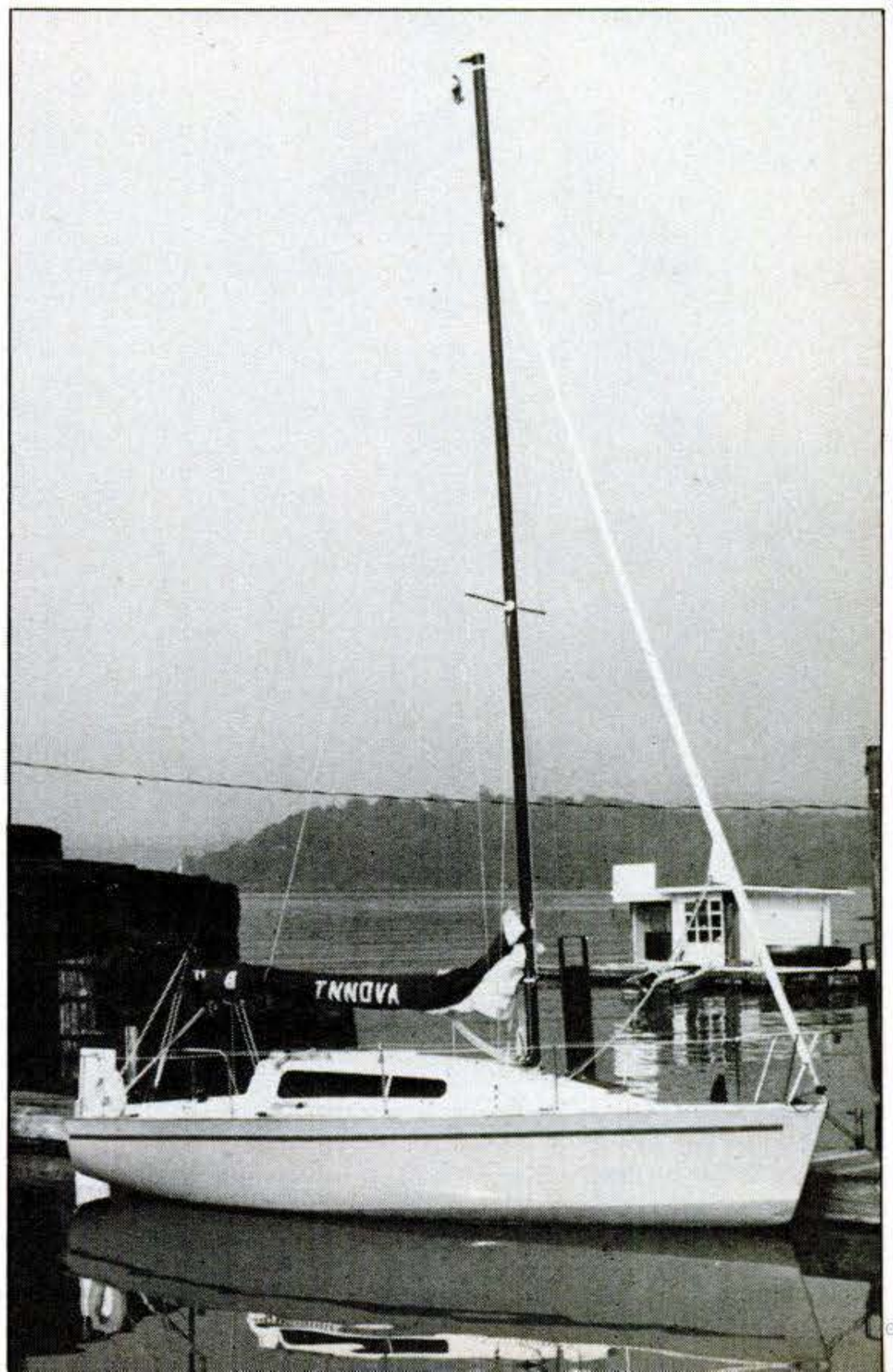
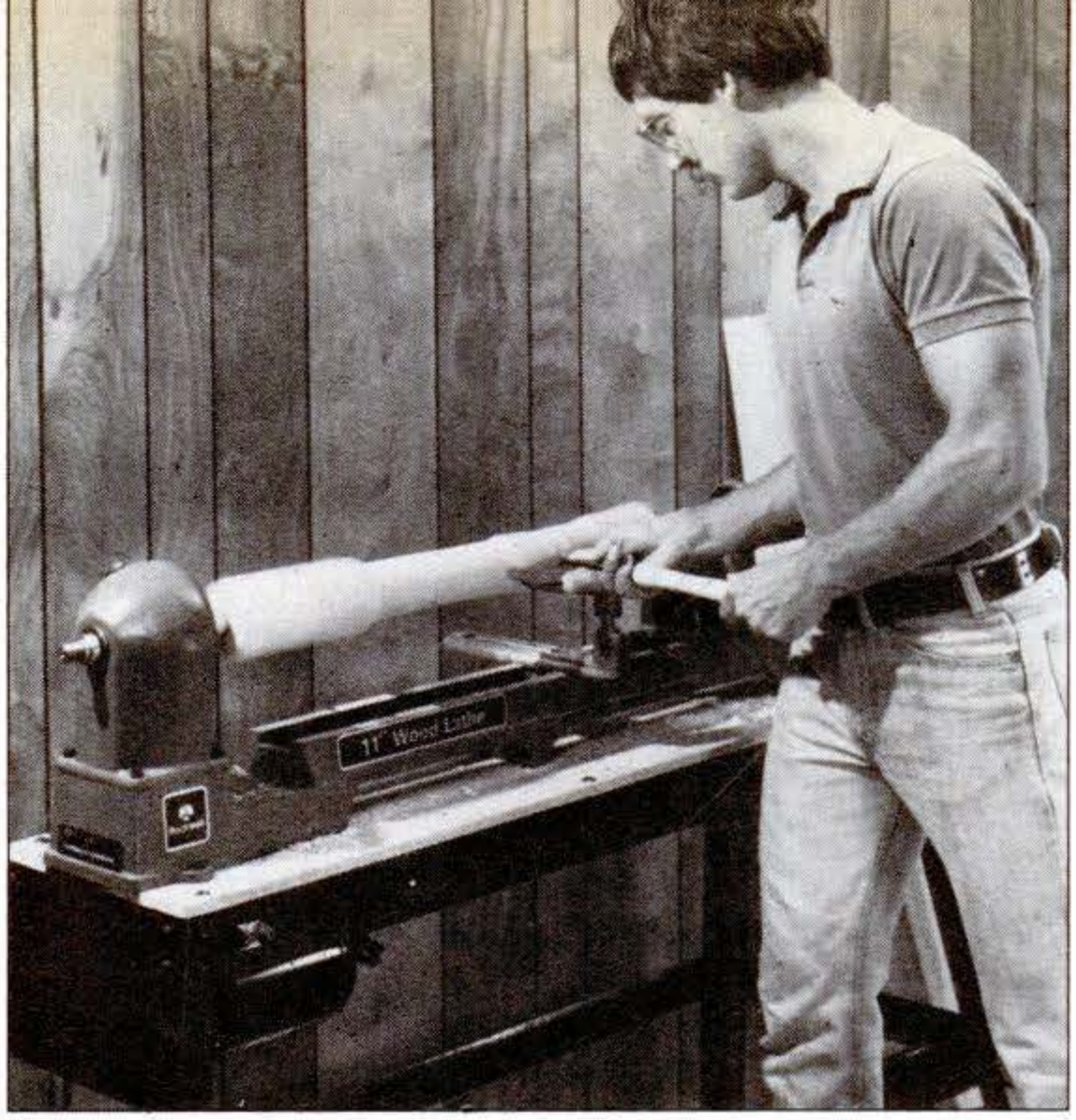


Plate mounts

How do you mount registration plates on a rubber inflatable? Snap a shock cord around these heavy-duty neoprene brackets and the plate is secure, says Recmar Marine Corp. (17875-B, Sky Park N., Irvine, Calif. 92714). The $6 plate attachment kit includes fasteners and special adhesive.

What's New IN TOOLS

BY V. ELAINE SMAY

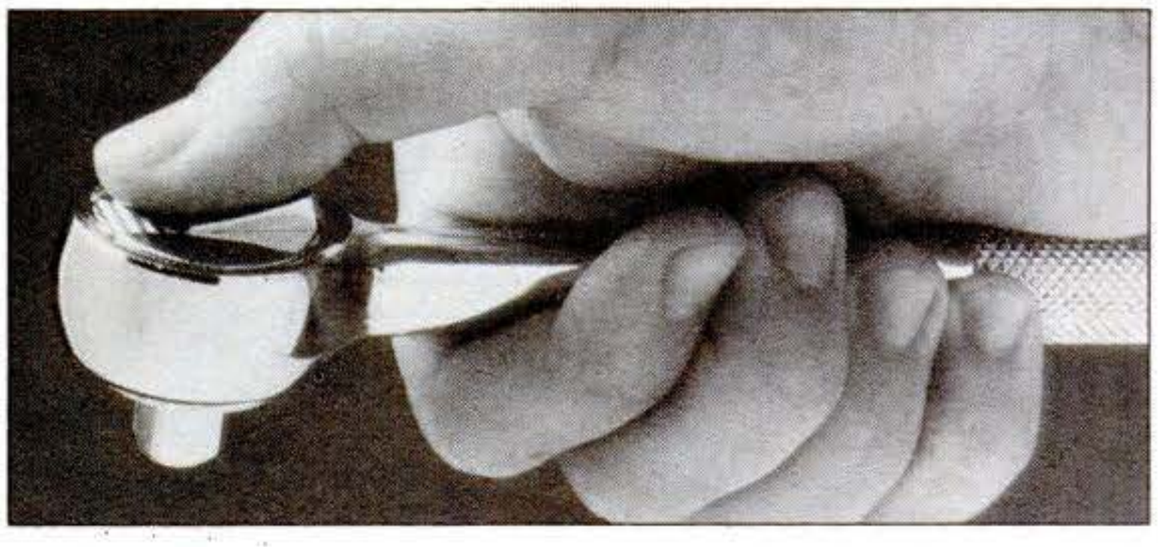


Expandable lathe

The bed on this new lathe from Rockwell splits down the center. Open it, and you can insert accessory sections to work on long stock. The standard bed takes 11-by-36-in. stock; 16-in. inserts can be added as needed. Price of the lathe: $350.

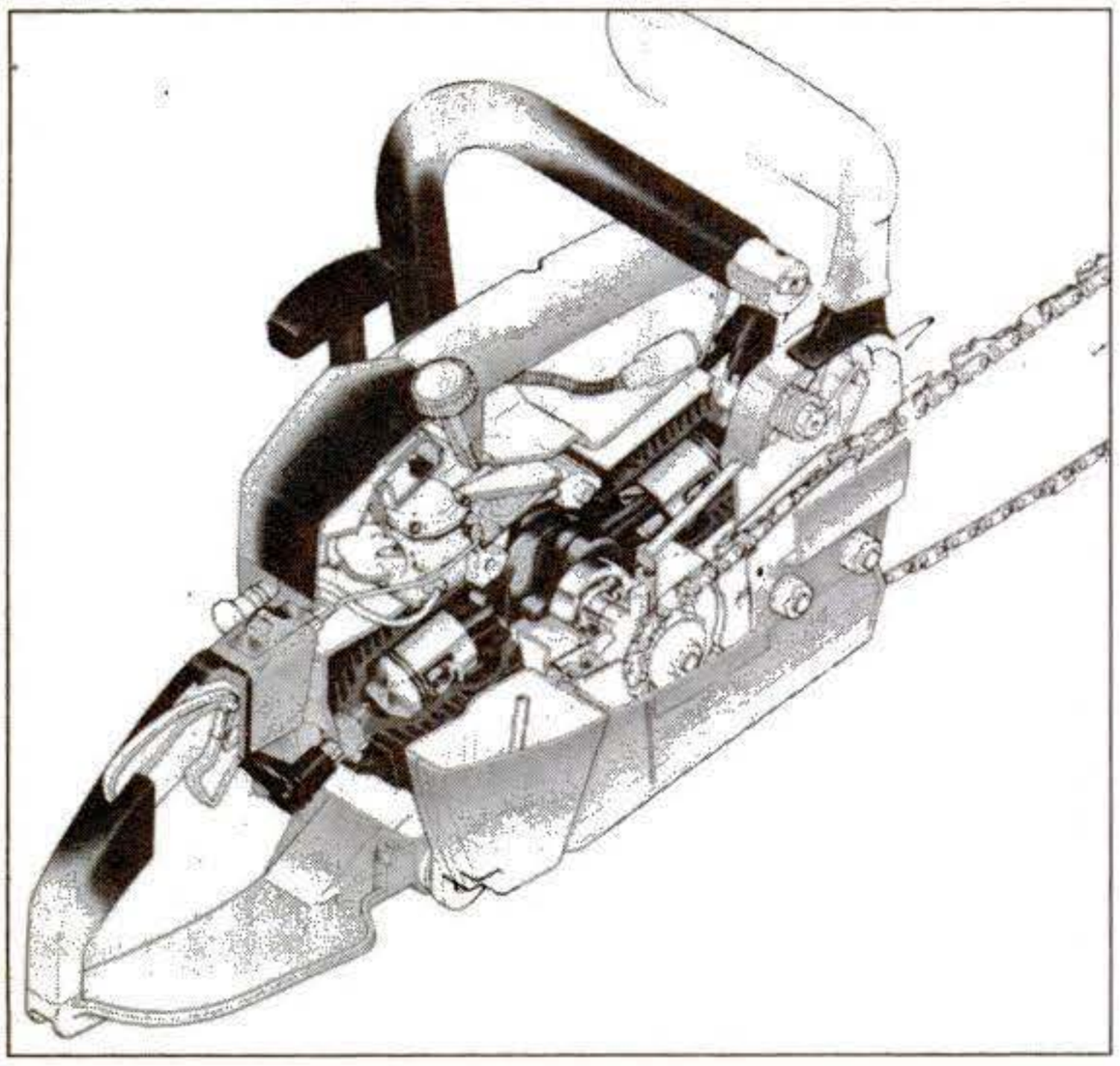
Electric roller

You'll speed paint jobs—roll-on or spray-on—with the Power Painter/Roller from Wagner (Box 9362, Minneapolis, Minn. 55440). The stationary pump feeds paint to a roller or spray gun (not shown) through a 25-ft. hose; extensions are available. The unit costs $400–$500.



One-hand ratchet

Changing the ratchet direction of Stanley's Flip-Drive wrenches takes only a touch of the rocker switch—a one-hand operation. Wrenches come in ¼-, ⅜-, and ½-in. sizes; they're sold alone, or in sets with sockets and accessories.



Planer-jointer

This power planer with stand converts to a bench-top jointer. The Black & Decker 7696 Surface Planer/Jointer cuts rabbets (to 5/16-in. depth), chamfers, and replaces several hand planes, says B&D. Cutting width, 3¼-in.; depth, 0.02 in.; price, $60.

Low-vibe saw

The twin-cylinder engine on the CST-600EVL chain saw has one-tenth the vibration of single-cylinder engines, says Echo, Inc. (3150 MacArthur Blvd., Northbrook, Ill. 60062). Horizontal pistons fire simultaneously and in opposite directions to offset each other's momentum.

Compact cordless

Lightweight (1½ lbs.), low-cost ($35) Model 2000 power screwdriver is a heavy-duty performer, according to Skil. You flick a switch to reverse the direction of rotation. The nicad battery recharges in three hours. One slotted and one Phillips bit are included.

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What's New IN HOME IMPROVEMENT

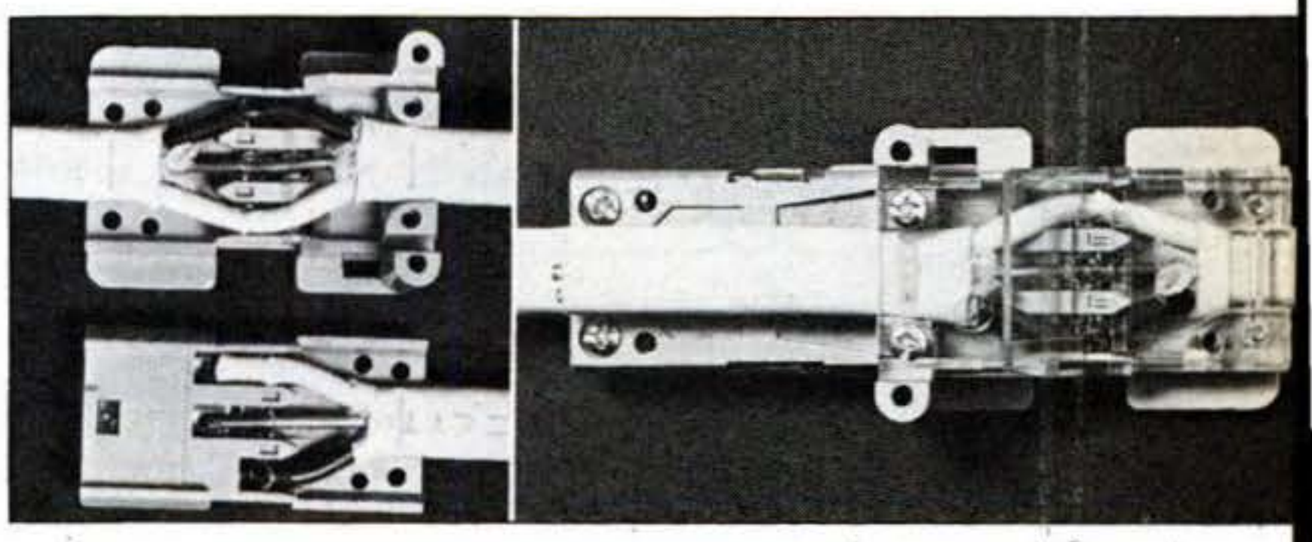
BY SUSAN RENNER-SMITH

Quick filler

Got a crack in your basement or patio? You can fix it with Epoxy Putty-Paste, claims United Resin Corp. (14570 Barber, Warren, Mich. 48093). The dripless plastic resin must be used within four minutes after mixing; it can be sanded and painted after 15. Price: $8.

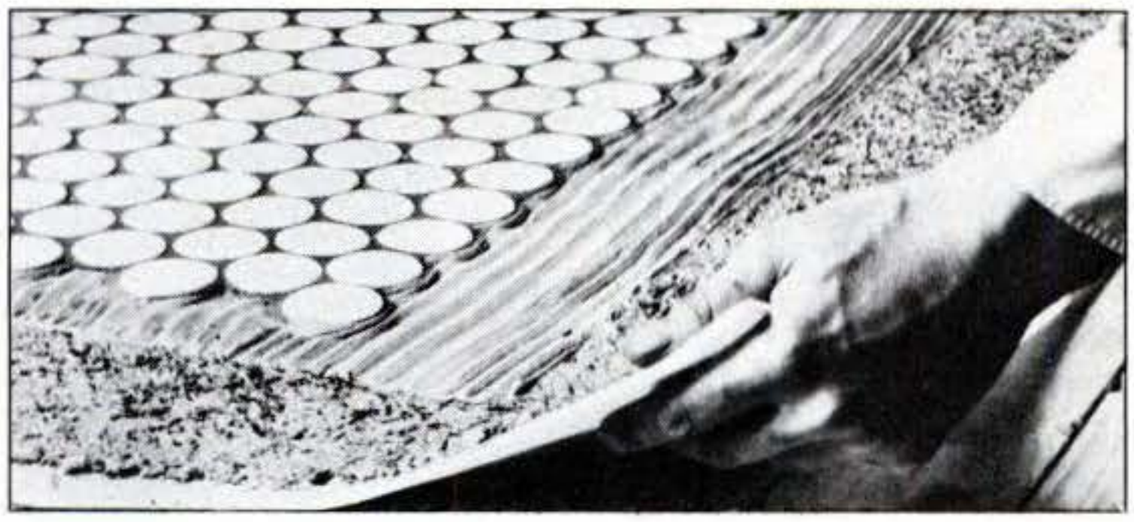
Modular swing set

You could suspend a small car from the frame of this backyard swing set, says Wooden Environments (1890 Evergreen Ave., Speonk, N.Y. 11972). Made of rot-resistant pressure-treated wood, the set is guaranteed against decay for 10 years. The components shown cost $975.79.



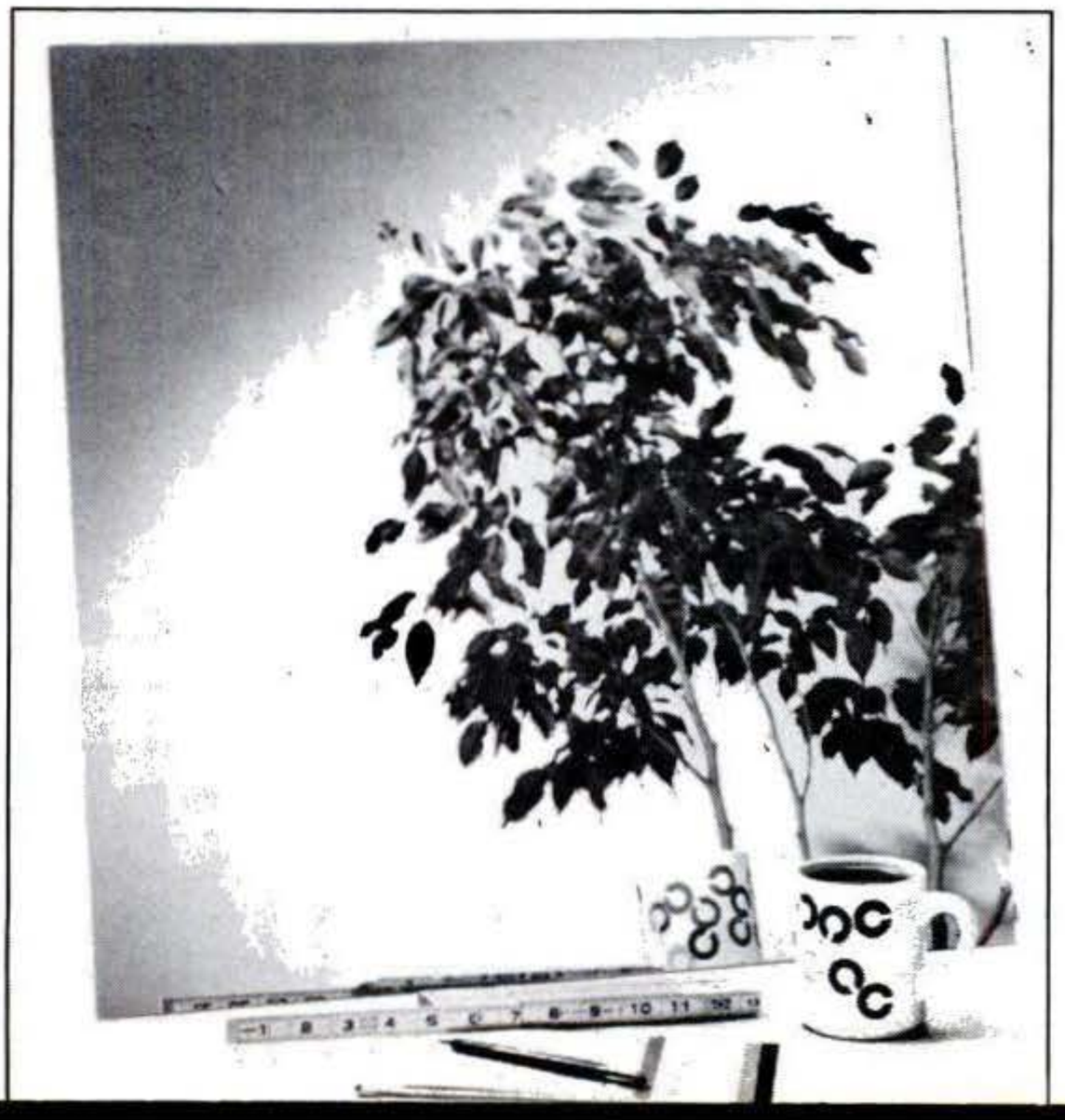
Soft ceramics

Lay ceramic tiles atop an uneven floor? A foam underlayment makes it easier, says Focus Ceramics (Weybridge, Surrey, England). In the Lazemoflex system, a rubber-based adhesive is spread on the foam, permitting subfloor expansion. Ceramic tiles are laid in the adhesive.



Quick tap

Forget junction boxes. To install the NM Cable Tap, strip off each cable's outer insulation and press the wires between insulation-piercing contacts (above left). Plug the plastic modules together and you've connected the cables (right). AMP (Valley Forge, Pa.) makes it for $5.



Room stretcher

It's twice as big as ordinary mirror tiles. So the new 24-in. Mirro-Tile should be twice as easy to put up. Mounting larger squares means fewer edges to align and less chance of split reflections. Price for two: $12.19. Hoyne Ind., 60 Gould Tower, Rolling Meadows, Ill. 60008.

Smoke light

A smoke alarm shrills—and this emergency light clicks on. Its yellow-tinted lens directs the light beam at a 45-deg. angle, making it easy to see through smoke. The $15 battery-powered Code One light mounts on the wall. Jameson Home Prod., 2464 Wisconsin Ave., Downers Grove, Ill. 60515.

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What's New IN ELECTRONICS

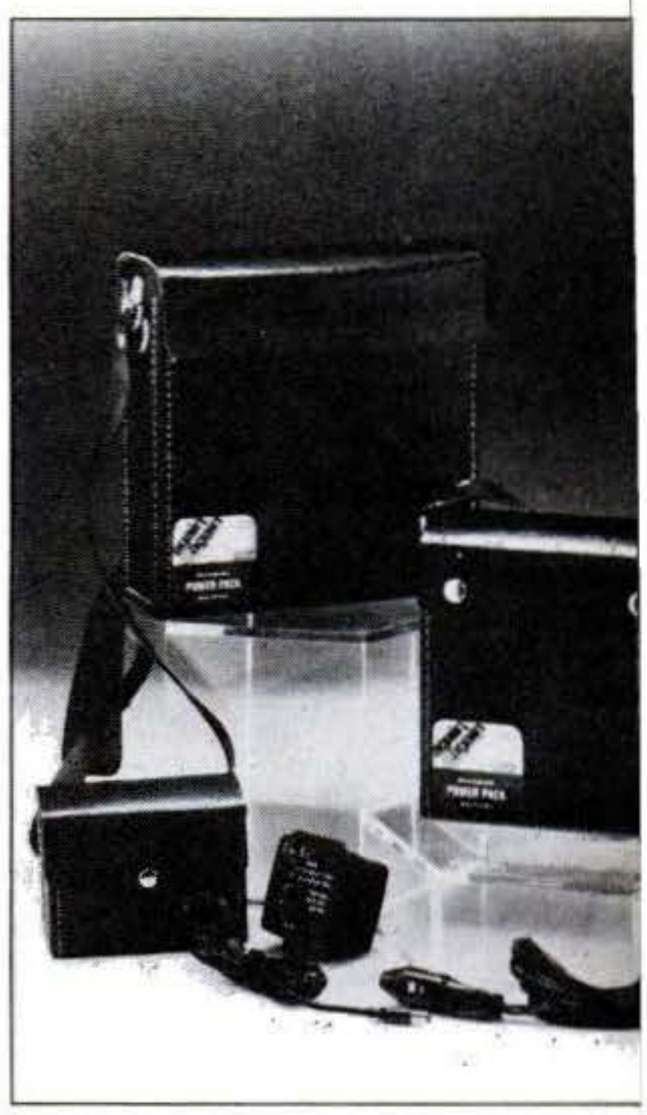
BY WILLIAM J. HAWKINS

Dot-matrix printer

Plug the MW100 printer directly into your Timex Sinclair computer, and the printouts you get will be clear and easy to read, says its maker. It uses plain paper and a dot-matrix print head. Made by Mindware, 70 Boston Post Rd., Wayland, Mass. 01778, it's $120.

Mouse tap

Tap those buttons, and the cursor on your computer's video screen instantly moves to any position. With the right software you can draw pictures, move blocks of text, or choose menu items. The Mouse is made by Random Access, 246 Highland Rd., Pittsburgh, Pa. 15235. $650.



Video for business

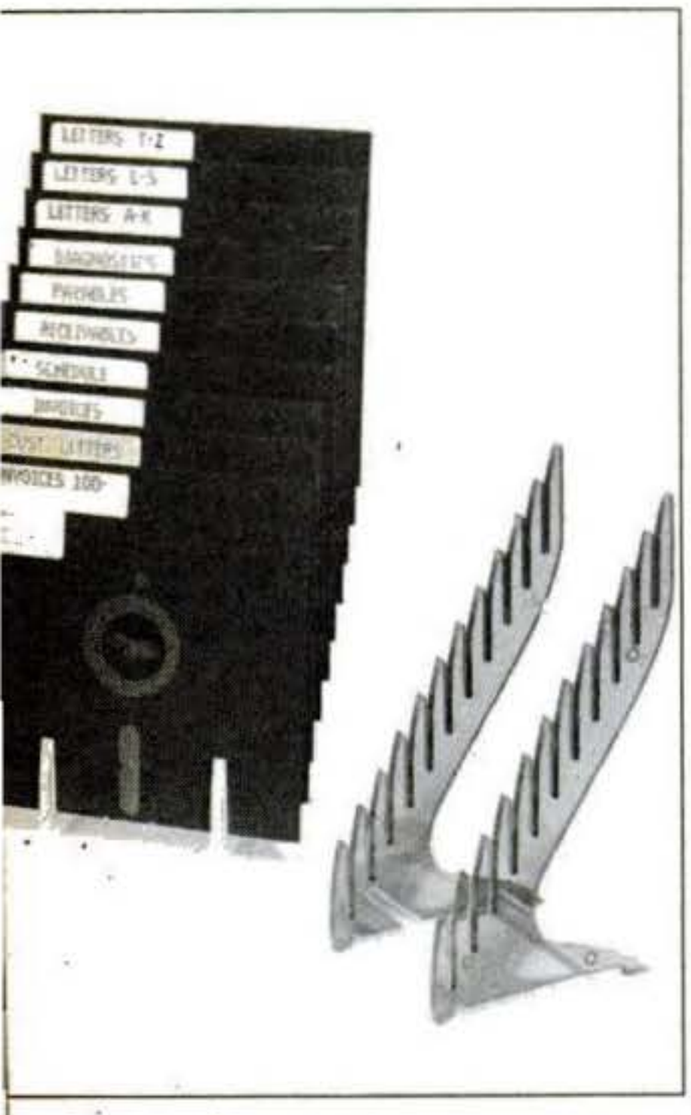
This projection system produces a six-ft. video picture with up to 50 footlamberts of light—that's a big, bright TV image, but it's not for your living room. The Sony KP-7240 is an industrial model specifically designed for large audiences and business meetings. $4,180.

Shirt stereo

According to its maker, Mura, it's the world's smallest FM/FM-stereo receiver: The Executive weighs just 2.5 ounces and measures 3/8 by 2 1/16 by 3 7/8 inches. The radio, including its 1/2-ounce earphones, easily fits in your shirt pocket. It's $70.

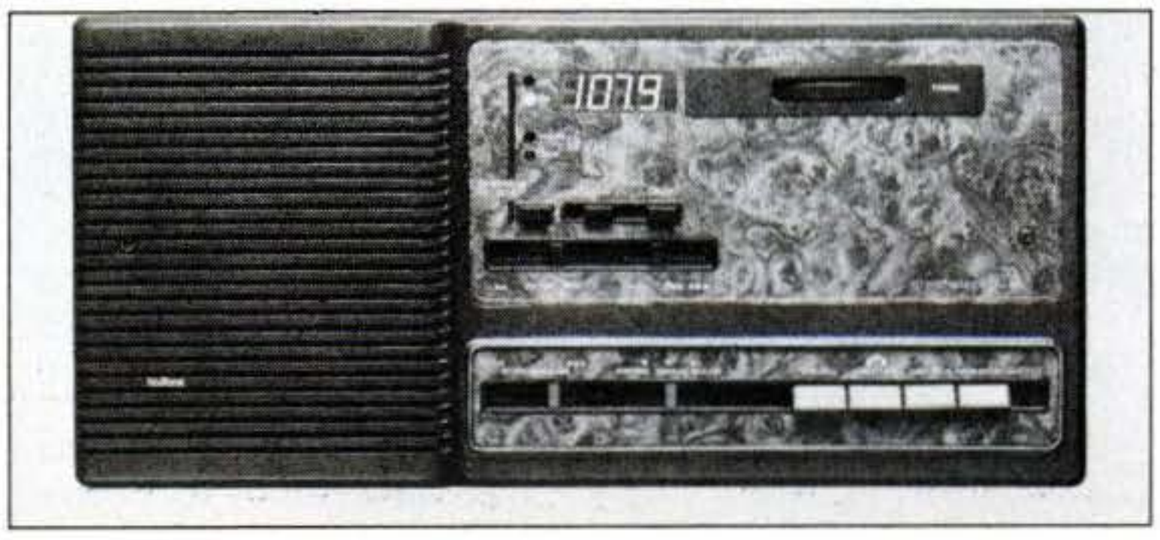
Super batteries

These Gelyte 12-volt power packs replace conventional rechargeable batteries for faster recharge and longer operating time. One for your VCR ($70) lasts up to three hours on a 16-hour charge. They're made by SAFT America, 931 Vandalia St., St. Paul, Minn. 55114.



Disc stacker

Your computer automatically organizes data on a disc. Great—but what organizes the discs? Try the Disk-O-Tier from ETS, Box 651, Willoughby, Ohio 44094. The smoked-plastic rack holds 11 small or large discs for a good view of their labels. Two for $19.



Outercom

All home intercoms allow communication between rooms. But this one, made by Nutone (Madison and Red Bank Roads, Cincinnatti, Ohio 45227), also gives you communications between houses. And you can answer the phone from up to 20 remote stations. Including AM/FM, it's $546.

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What's New
FOR YOUR CAR

BY JACK KEEBLER

Hitch cover

Protect your shins from bumps—and your trailer hitch from the weather—with a soft vinyl cover from BP Enterprises (Route 2, Viking Lane, De Pere, Wis. 54115). Hitch Guard comes in 2-in. ($3.79) and 2½-in. ($3.89) sizes for Class 1 and 2 hitches.

Powerful wrench

Black & Decker's ½-in.-drive electric impact wrench develops 120 ft.-lbs. of torque to make quick work of tire changes and bolt removals. The tool features convenient forward and reverse operation and is double-insulated. Its 10-ft. cord plugs into 120-V outlets. Price: $97.48.

Pickup cover

Box Top bolts to your pickup's bed in minutes to provide the security of a locked trunk, says Viking Formed Products (Box 725, Middlebury, Ind. 46540). Made of lightweight fiberglass and aluminum, it opens from either side for easy access. Price: $350.

Tiny reminder

Forgetting to turn your headlights off on a rainy or foggy morning can cost you a service call or leave you stranded. This tiny buzzer sounds if you turn the ignition off and leave the lights on. It's $9.95 from Warren Imports, 725 Mills Rd., Don Mills, Ont., Canada M3C 1S7.

Tool cart

Tired of stooping and stretching to reach screwdrivers and wrenches? Roll the Craftsman Tool Caddy up to the work area and adjust the tray height to put things within easy reach. It adjusts from 17 to 40½ inches. Sears sells the caddy for about $90.

See-through slats

Metal louvers keep hatchback cars cool inside, but they can cut rear vision. Bolt-on Parts, Inc. (Box 1031, Woodland, Calif. 95695) solves the problem with smoked-acrylic louvers that screen out much of the sun's rays without creating blind spots. $210.

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10 hot new planes—and a $6,450 kit motorglider that **flies all day on a gallon of gas**

From ultralights to commuter craft, they seek fuel efficiency

By BEN KOCIVAR

In the Los Angeles suburb of Monterey Park, Calif., police are flying airborne patrols using ultralight aircraft, the motorized fabric-wing craft [PS, Jan.] now drawing thousands of new fun flyers. The cops can buzz to any city location in a few minutes. And the ultralights, which cost less than cars, take only about $5 an hour to operate. That compares with up to $500 per hour for a helicopter.

But recreational flyers may value more highly how long they can stay aloft without refueling than they do operating costs. And the Monerai sailplane-motorglider (cover and facing page) represents new highs in performance. Fill its one-gallon tank with gasoline, take off (without a tow plane), and you can remain airborne all day. You just rev up the 22-hp engine once in a while to skip from one thermal to another.

The Monerai's 39-foot wingspan and sleek, lightweight engine offer daring designs for maximum performance from a recreational aircraft. But such exotic new plane designs aren't that unusual, as I discovered this year at the big air show in Hanover, Germany. The reason: soaring fuel costs, which have devastated major airlines.

"I remember when planes were considered better if they flew faster," Klaus Mindner, a Luftwaffe jet-fighter pilot, told me away from the buzz and roar of engines. "But the designs you're seeing here have a new mission—to keep flying costs down."

The fuel-efficient designs I saw ranged from the ultimate—a solar-powered electric-motor craft—to more practical short-haul commuter airliners. New approaches include the use of lightweight, computer-designed wings; composites instead of heavier metal; and unusual aerodynamic features for enhanced maneuverability.

The Monerai, with wings like a mini U2 spy plane, is a paragon of things to come in aircraft design. A Monerai starts as a kit at the Monnett Experimental Aircraft Co. in Oshkosh, Wis. The motorglider, with its aluminum-covered wings and fiberglass-pod fuselage, can be assembled in about 400 hours.

Wing-tip extenders

Monnett's latest modification to the Monerai: fiberglass wing-tip extenders that add about one yard to the sailplane's span. The modification boosts the glide ratio from 28:1 to 33:1. With a new KFM 107 engine, and the prop stopped in flight, this glide ratio drops to about 23:1. But that's as good as most basic gliders *without* engines. The company is also readying a feathering or folding prop, which would reduce wind resistance when the engine was not being used.

John Monnett, designer and president of the company, is pleased with the extenders and new engine. "Results on the factory prototype have been so positive we're releasing the modifications to owners slightly ahead of schedule," he said.

The kit price for the Monerai, $3,950, is lower than the price for used sailplanes. For powered flight, a pod-mounted, two-cylinder, two-stroke engine is added to the fuselage top. This $2,500 power pack can be attached or removed depending on the kind of configuration you want.

A quite different approach to fuel-efficient distance flying doesn't use any fuel at all. Paul MacCready's Solar Challenger [PS, June '81], Freddie To's Solar One [PS, July '80], and other aircraft have demonstrated the concept of sun-powered flight. At Hanover I saw the first German solar machine, a plane with canard wings and a pusher-type prop.

Gunther Rochelt, a 42-year-old aircraft designer from Munich, put $28,000 worth of solar panels on his Solair I. "To keep it light and strong, I made Solair I mostly of Kevlar," Rochelt told me. (Super-tough Kevlar is also used for bulletproof vests and clothing.) The aircraft's wing spar is 20-mm Styrofoam covered with Kevlar fiberglass.

The 250-pound Solair I has a 53-foot main wing and 13-foot canard. Solar cells on these wings power an electric motor that spins an 8.7-foot, fold-back prop at a leisurely 450 rpm. Flight is almost totally silent.

Powered ultralights with solar panels will remain rare until photovoltaic-cell costs are reduced. But another new look is coming soon. A German version of the gasoline-powered Hummer ultralight—a kit from MaxAir Sports (Glen Rock, Pa.)—represents a significant change in these personal aircraft. German dentist Dr. Carl Booth of Oberteuringen, W. Germany, has devised a *two-seater* ultralight, available with foam-filled floats. It's being built by MaxAir's agent in Germany.

"You're going to see lots more two-seater ultralights for improved safety," says Bill Hanson, MaxAir's director of operations. "Within one year I think every manufacturer will be pro-

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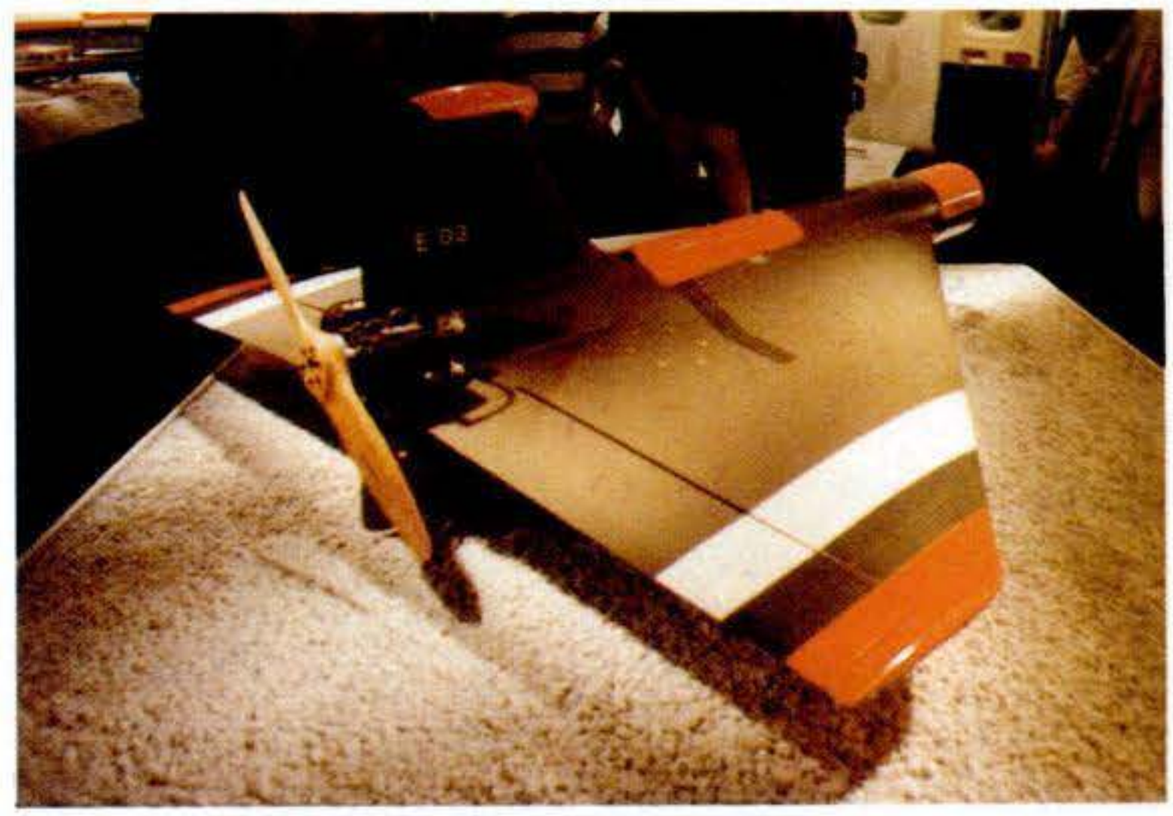
Giant wings and canard of Solair I, a new German design, are covered with solar cells to power its electric motor and prop. Prop blades fold back (insets) in gliding flight to cut drag. Wing-tip rudders set up drag on inside of turns.

Two-seater ultralights, such as this variation on the familiar Hummer single-seater, are coming from many kit firms. Second seat makes in-flight instruction possible to improve safety. Optional floats on German model permit flights from water.

Electric-start KFM 107 engine for Monerai motorglider (cover) makes airborne restarts feasible. Engine has smaller frontal area than previous engine to reduce drag and stretch fuel in one-gallon tank. Over 350 kits are under way or assembled.

Rugged Dornier turboprop can serve as commuter aircraft or in functions, now being planned, such as maritime patrol craft equipped with bulbous-nose search radar and big bubble windows. New-technology wing was tested on Skyservant 128.

Optimum fuel economy for regional airliners is goal for Saab-Fairchild SF-340, slated for its first test flight next year.



Deadly delta-wing drone has 6.6-foot wingspan and small pusher prop. Dornier's craft may serve as harassment drone.

ducing a two-seater, and it won't simply be a matter of adding another seat. The whole plane must be strengthened."

In the U.S., MaxAir is also readying a two-seater. The kit will cost $5,500. The aircraft has a 40-foot wingspan, and you'll be able to choose between a three-cylinder, 20-hp engine and a hotter five-cylinder motor. These new two-seaters, unlike many foot-launchable ultralights, can be flown only by a licensed pilot.

Hanson estimates that some 6,000 powered ultralights are flying. The growing popularity of these personal aircraft has inspired some big-name plane manufacturers to consider entering the market.

Takeoff for ready-mades?

Despite the fascination with ultralights, they're still dismissed as flying toys by some. A different direction in personal-plane design—toward greater sophistication—is emerging from Grob-Werke. This German aircraft firm has produced some 2,000 composite sailplanes and motorgliders [PS, Aug.]. Now, despite the setback of a prototype crash, it is starting to produce a sleek two-seater aircraft, the G 110 with many unusual features.

This fiberglass plane is powered by a 118-hp Lycoming engine with a new Hoffman constant-speed propeller. The G 110 can cruise economically at 132 mph, its smooth, rivetless lines contributing to a miserly fuel consumption of only 4.6 gallons an hour.

All-composite planes aren't new. Burt Rutan has created exciting designs [PS, Aug. '81; May '82] with these supertough, lightweight materials. His planes, however, are aimed mostly at build-it-yourselfers. Grob-Werke will turn out complete fi-

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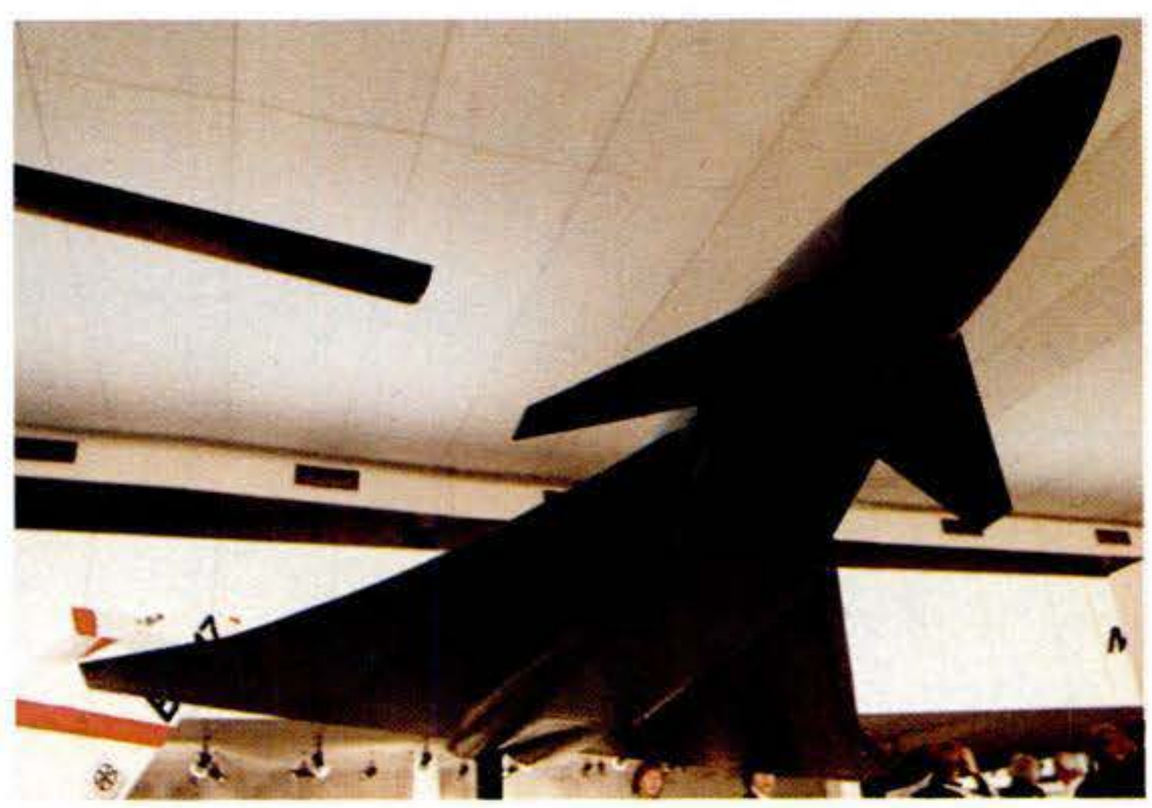
Anti-ship and anti-submarine weapons bristle on the Aerospatiale Dauphin 365F, French Navy version of civil chopper. Two 710-hp turbine engines propel the high-endurance 365F at 177 mph. The U.S. Coast Guard has purchased another version.

Movable canard wings ahead of main delta wings on proposed Swedish fighter will greatly enhance its maneuverability.



Super agility is promised in German joint-venture fighter based on movable canards and 40 percent composite airframe.

berglass G 110's from its assembly lines. And a more powerful version, the four-seat G 111, may be ready in a few years.

Fuel efficiency for small, private aircraft such as the G 110 is certainly welcome. But for major airlines and short-haul commuter firms, efficiency is more than just welcome—it's vital for economic survival. Some 5,000 new turboprop planes with 15-to-100-passenger capacity may be built by 1990. Here are some of the new planes commuter airlines are eyeing:

- The SF-340 is a joint U.S.-Swedish twin-turboprop aircraft designed as a 34-passenger regional airliner or 16-passenger executive plane. To achieve low noise, it uses four-blade composite propellers. The 340 airframe is designed for 90,000 takeoffs and landings—far more than current regional short-haul airliners. Cockpit avionics, with CRT's displaying various data, resembles readouts on the new Boeing 757 and 767 [PS, Nov.].
- ATR-42's, somewhat larger than the SF-340, will carry 45 passengers and cruise at about 300 mph, with a range of about 900 miles. This twin-turboprop is a joint French-Italian project.
- The Dornier 228 from France, now flying, features an advanced wing [PS, Nov. '80]. Its rivetless wings are cut from two-inch-thick aluminum sheets by computer-controlled milling machines. The milling technique for parts trims weight 15 percent. The boxy, high-wing turboprop comes in 15- and 19-seat versions.

These aircraft and others projected for the next decade appear in amazingly varied designs. Whether from tinkerer's garages or the wind tunnels of major aerospace firms, they are coming more and more to share a common goal—fuel efficiency. PS

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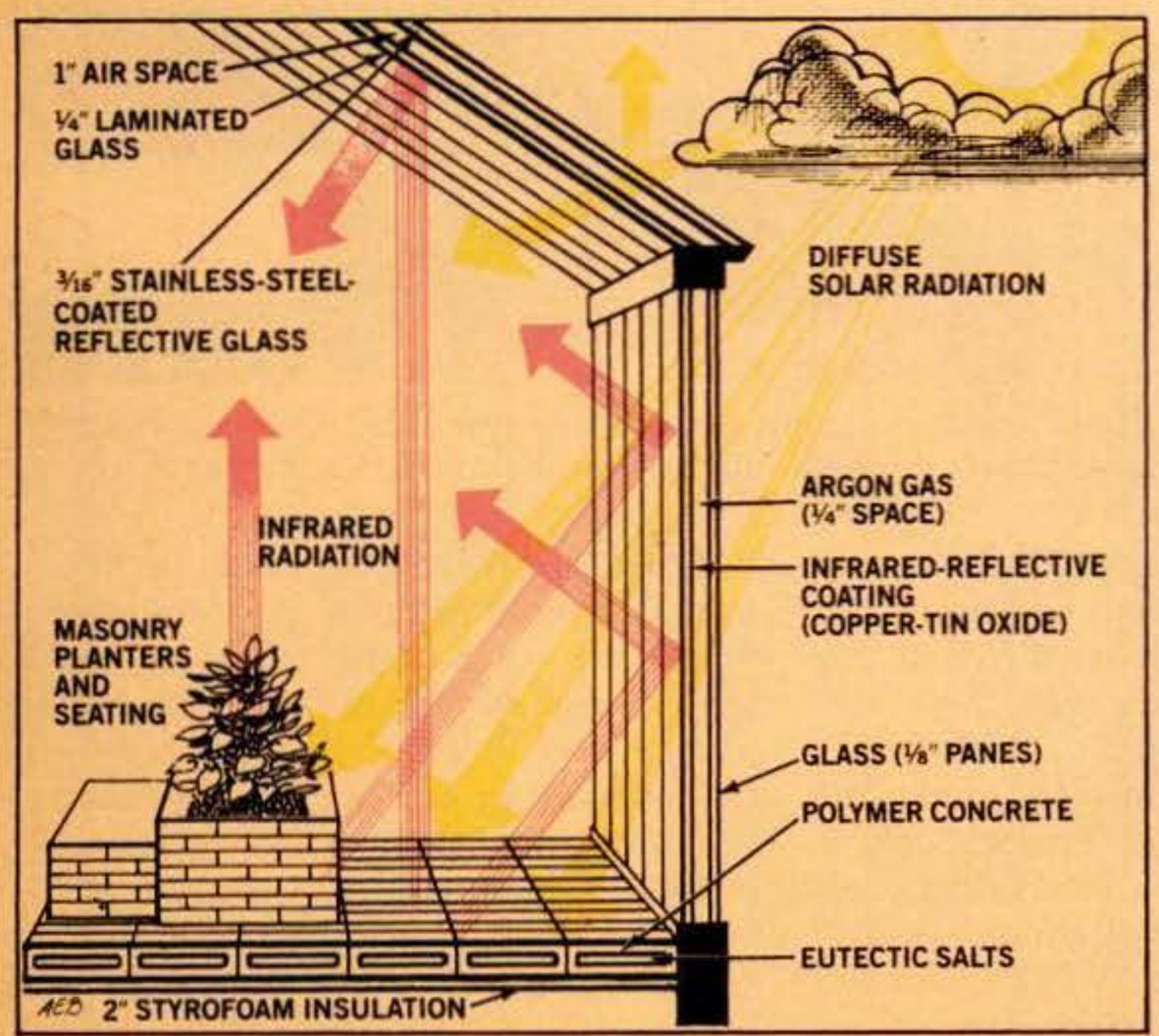
MIT's solar pavilion

—glass house for a cloudy climate



Experimental solar structure has panels of glass attached to a steel superstructure by redwood battens, which serve as thermal breaks (top). Diagram: Double-glazed walls have a special coating that reflects infrared radiation emitted by room-temperature objects yet admits most of the incident solar radiation. Glass roof is coated to reflect 60 percent of the incident solar radiation. In summer, the space between panes is vented to dissipate the heat that is absorbed. Floor tiles (interior photo above) contain eutectic salts, which absorb solar heat. Above their phase-change temperature, the salts are liquid. As room temperature falls, the tiles give up heat. Eventually the salts crystallize, releasing latent heat. Masonry surfaces also store solar heat.

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A solar home without a southern exposure? This building shows the way

By BOB HIRSHON
PHOTOS BY GREG SHARKO
DRAWING BY ADOLPH BROTMAN

CAMBRIDGE, MASS.

The Crystal Pavilion, the latest solar-heated test structure here on the campus of the Massachusetts Institute of Technology, was carefully and painstakingly ill-conceived. The all-glass structure's pitched roof is made of reflective glass, rejecting the high-energy rays of the midday sun. In the afternoon, the building shivers in the shadow of Solar Five, another MIT solar-heated prototype [PS, June '78]. While most solar-heated buildings try to take full advantage of all the sun's photons, the Crystal Pavilion artfully avoids them.

Professor Timothy E. Johnson, principal research associate in the department of architecture, and graduate student Brian Hubbell designed the 490-square-foot structure to prove a point: that solar heating, usually limited to sunny locales, will work in areas where overcast skies are the rule—areas such as the Pacific Northwest and much of Northern Europe. Rather than setting up shop in Seattle or Scotland, however, the MIT team simulated that kind of climate through building design. They oriented most of the glass to the north and east to capture mainly diffuse and reflected sunlight. South glass was minimized. The west wall is opaque, abutting Solar Five.

The Crystal Pavilion uses new-technology materials, proved effective in Solar Five, to ensure that what solar energy does get inside spends the night—and several succeeding days and nights. Infrared-reflective glass traps heat in the building and special floor tiles containing eutectic salts store it.

But while Solar Five shows what these materials can do under ideal conditions, the Crystal Pavilion tests them under adverse conditions. The goal: 100 percent solar heating as long as the outside temperature remains above 42 degrees F. And the sun is to provide most of the building's heat even during Boston's coldest winter months.

The combination of IR-reflective glass and heat-storing floor tiles could make possible passive-solar houses without a southern exposure, Johnson maintains.

The Crystal Pavilion's glass walls transmit 70 percent of the visible light (standard windows transmit 80 percent) and 63 percent of the incident solar energy (compared with about 74 percent for conventional double glazing). But they reflect 85 percent of the long-wave infrared radiation emitted by room-temperature objects. As a result, the building's interior heats up via the greenhouse effect: Mass within the structure absorbs incoming solar energy, heats up, and slowly radiates that energy to the room as infrared radiation, which remains trapped within the IR-reflective structure.

The question most often asked of Johnson and Hubbell is: Doesn't a regular glass structure heat up in the same way? Isn't that what the greenhouse effect is?

"The greenhouse effect as it is commonly described is a hoax," answers Hubbell. "It assumes that regular glass traps infrared radiation. That simply is not true.

"Of course, greenhouses heat up," he is quick to add, "but not because glass can't pass infrared. Greenhouses heat up because solar energy transmitted through the glass heats up mass within the greenhouse, which emits infrared radiation, heating the air. Since the glass enclosure prevents the warm air from blowing away, the greenhouse feels warm. But the old explanation that glass prevents the escape of infrared radiation is nonsense. It doesn't *transmit* it the way it transmits visible light, but it *absorbs* it like crazy and reradiates much of it back to the great outdoors. So the end result is the same." This is why greenhouses, especially those with little heat-holding mass inside, rapidly cool off when the sun goes down, Hubbell points out.

Capturing and storing heat

The Crystal Pavilion's IR-reflective glass, used for the inside pane of the double-glazed walls, was provided by Airco Temescal of Berkeley, Calif., and Guardian Industries of Carleton, Mich. It reflects long-wave infrared radiation because of a transparent coating of copper-tin oxide on one side of the pane ["Wonder Windows," PS, April]. In addition, the double glazing is hermetically sealed—with argon gas instead of air between the panes. This reduces convective heat transfer, supplementing the effect of the reduced radiation. Result: The Crystal Pavilion's windows have nearly three times the insulating ability of conventional double glazing.

Even with superior insulating glass all around, however, the building would lose its solar heat too quickly if it had no way to store it. The special floor tiles, made by Architectural Research Corp., Livonia, Mich., perform this function. The tiles are two-foot squares of polymer concrete with a core of phase-change salts. The salts, primarily Glauber's salts, melt as the building heats up, absorbing large quantities of energy (220 Btu per square foot) as they change from solid to liquid. As the building cools, they freeze, releasing that stored energy in the form of heat.

Chemically, the salts consist of sodium sulfate, water, Cab-O-Sil (a silicon dioxide thickening agent), borax, and sodium chloride. The phase-change temperature is 74 degrees F. Aging and settling problems previously encountered with phase-change salts have been overcome by packaging thin layers of the salts in aluminum-foil-covered plastic packets only ⅜-inch thick. According to Johnson, that approximates the long dimensions of a single salt crystal. Salts packaged this way show no sign of aging after several years of testing.

Heat released by the tiles will keep the structure comfortably warm indefinitely through cloudy weather with temperatures above the design goal. Even during Boston's cold winters it will sustain the structure for three very cloudy days. After that the building requires a shot of sunshine to recharge the tiles. Or the backup electric-resistance heating system is used if necessary.

Measurements taken late last winter indicate that on a cloudy day near the equinox the temperature inside the Crystal Pavilion peaks at about 23 degrees F warmer during the day than the outdoor ambient temperature, and remains about 16 degrees warmer at night. The difference will be lower in midwinter when days are shorter, the researchers point out.

"One hundred percent solar heating isn't a mysterious thing," Hubbell says. Initial tests indicate that the Crystal Pavilion achieves that goal, even on cloudy days, as long as the outdoor air temperature remains above 44 degrees F. Testing will continue through next year.

The MIT team was as concerned with making the building comfortable and aesthetically pleasing as with making it perform well. Hubbell's design includes brick planters and built-in seating, with a variety of interior spaces defined by level changes. Earth colors blend with the cool colors of the glass-and-steel structure.

"You could build something like a Thermos bottle that doesn't lose *any* heat," Hubbell says. "But who'd want to live in it?"

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Transform an under-used cellar into an elegant

basement suite

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You can study, dine, or make a party in this multipurpose living area

By CHARLES A. MILLER

A home is made for enjoyment, but if your family is typical, full enjoyment calls for more room than you've now got. If your house has a basement that's currently being used only for storage (or housing the family pet), additional living space is readily at hand.

The basement of the town house shown here was a combination laundry room-storage dump before being converted into this attractive family suite. It was created by Masonite Corp. as a showcase for prefinished hardboard paneling. The panels shown are called Woodfield, a narrow-groove textured board that comes in standard four-by-eight-foot sheets.

To achieve a similar transformation of your basement, start with a plan to scale (½ inch = one foot) that shows the location of all permanent objects such as the furnace or boiler, tanks, washtubs, support posts, and so forth. Try to isolate utility items from the living area by carefully plotting the location of partition walls. In our example (next page), a stud wall of 2×4's on 16-inch centers was erected between the laundry area and the rest of the basement.

Next, in red pen, draw in the location of lights, vents, exhaust fans, and other obstacles that extend from the ceiling. Now draw a pattern of one-inch squares (representing two-by-two-ft. ceiling tile) on a piece of tracing paper. Move the tracing paper over the plan so that the obstacles clear any of the seams in the tile. You may find that you'll have to reposition lights and other movable fixtures to ensure that support strips don't interfere (given the limitation of a reasonable starting point for the tile).

The Woodfield paneling from Masonite is designed to be butted together over stud framing. Use adhesive or color-coordinated finishing nails vertically spaced 12 inches apart to mount the panels directly to the studs. Paint the edge of all studs that stand behind panel joints black so that if the panels contract later because of weather, the gap won't be noticeable.

Use 2×2 stock to fur out along pe-

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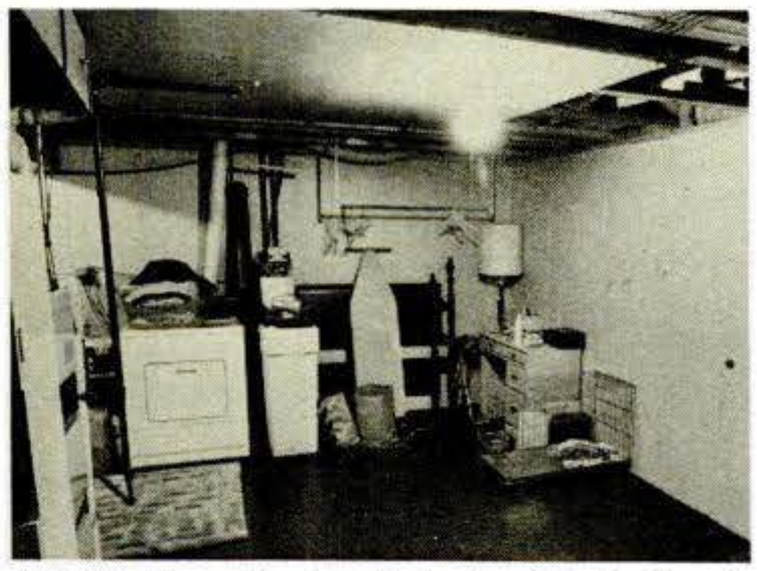
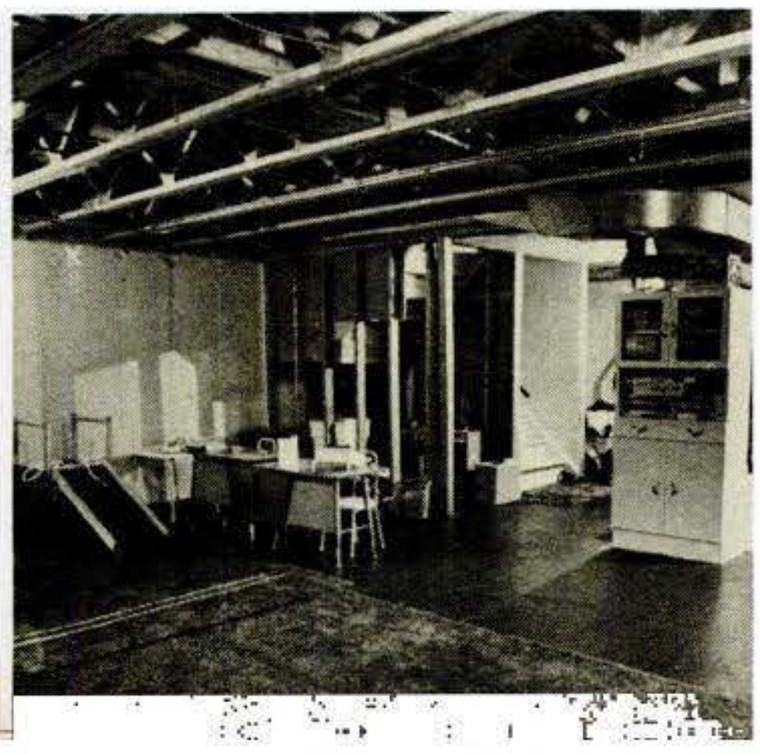


Match these "before" shots with their color counterparts to appreciate what partitions, paneling, and furnishings can achieve. Study/entertainment area at left began as waste space in top photo. Recessed shelving in cozy dining nook is built into partition that hides old laundry area ("before" shot above). Open stairwell (below) was enclosed for storage.



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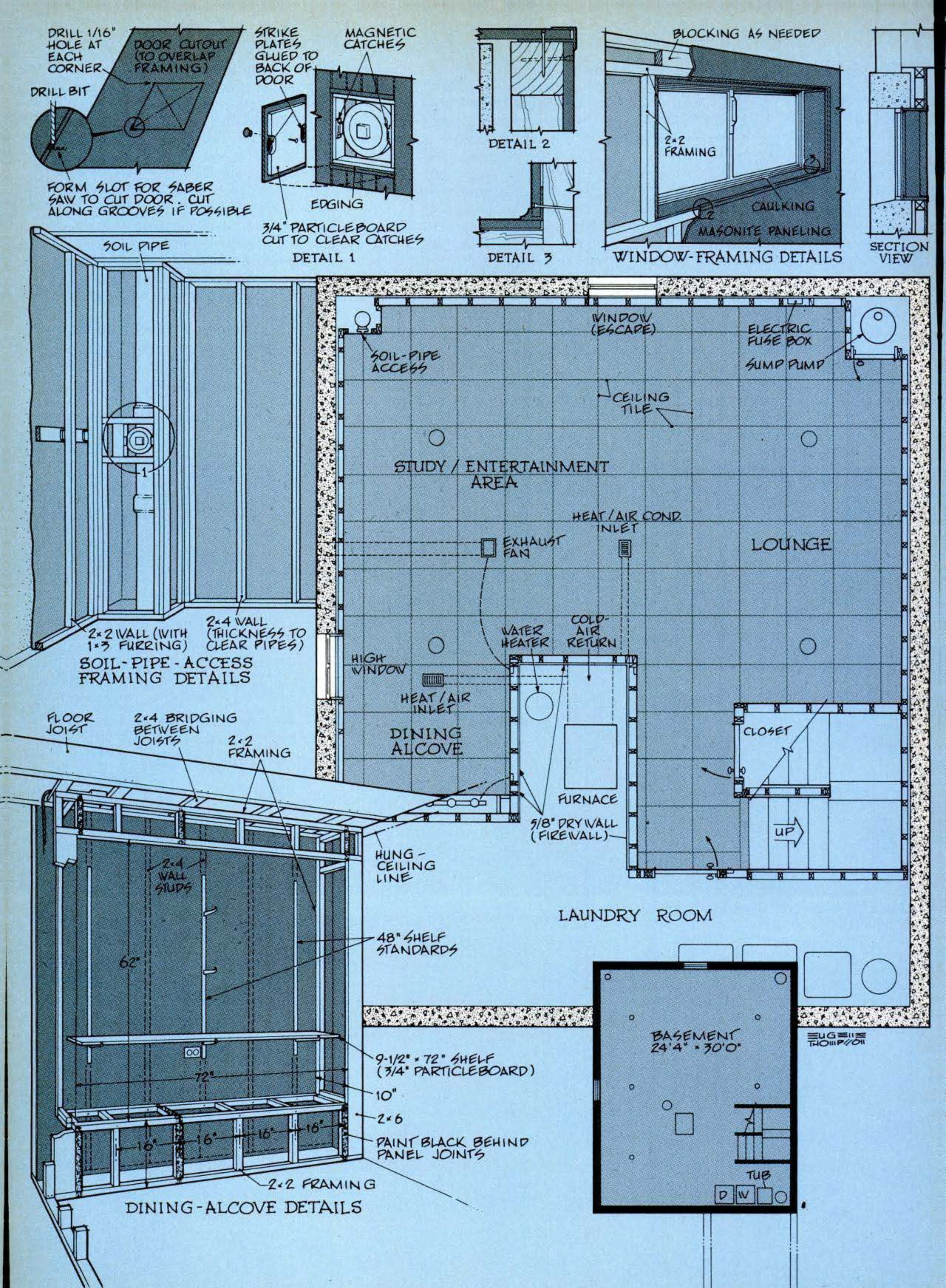

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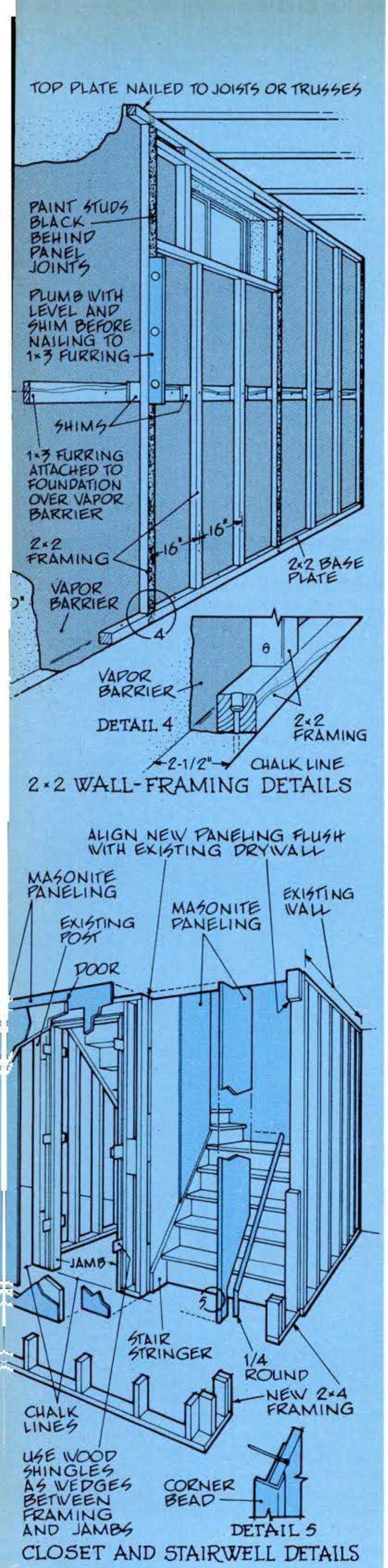

rimeter walls except where obstructions must be cleared. Where small pipes and conduit protrude, frame out the entire wall length with 2×4's. Frame, too, around soil stacks, valves, electrical panels, and other fixtures that you'll have to get to from time to time so that access can be easily provided.

In our example, a small door was built in the framework around a soil pipe for access to the cleanout. A corner was built out and a full-length door added to maintain a passage to a sump pump.

To build small access ways, first measure the obstruction to determine the best location for an opening. Now, cut the framing for this opening to size. With a sheet of paneling lying face up on the floor, position your framing for the neatest effect with the panel grooves, letting the cut lines fall on the vertical grooves wherever possible.

Now drill 1/16-inch holes at each corner of the opening. Mark a saw line between the holes. At two opposite corners drill several more holes close together along the saw line, forcing the drill back and forth to make a slot for the saber-saw blade.

Now turn the panel over and mark the cutting line of the opening between the corner holes, slip the saw blade into the drilled slots, and cut out the access door.

When you're finished, sand the edges of the opening smooth. If you put edging strips around the opening, any sawing imperfections will be concealed.

Glue a piece of particleboard or plywood to the back of the piece you've cut out to make a cover, and add a small handle and strike plates. Install the framework and add magnetic or other suitable catches to hold the cover in place.

Our stairwell closet was framed with 2×4's and covered with 1/2-inch dry wall before mounting the paneling. The door framing was positioned so that the door was centered on the short wall. Measure the distance from the edge of the panel to where the door opening is to be cut out, and adjust so that at least one cut line will fall along a panel groove.

Lay the door panel in position on the back of the paneling and trace its outline. Remove the door, put the panel on saw horses, and carefully cut the outline (from the panel's back) using a saber saw or trim saw, being sure to pad the front so as not to scar the finish.

Coat both the door and the back of the cutout paneling with contact cement and bring the coated surfaces together when the cement is tacky. (You'll want to use the slipsheet technique to ensure alignment, since you can't separate the pieces once you've started.) Roll the paneling with a rolling pin to be sure the bond is tight around all edges.

Now nail the wall paneling in place and hang the door. Add the stairwell paneling, including the corner beads. Note that the lower edge of the panel is cut on an angle to match the top of the stair stringer. Any imperfections along the cut edges of the paneling can be hidden by trim pieces.

The bookshelves are framed with 2×4 and 2×2 stock. After the main dividing wall is framed, install the back sheet of paneling before building the front section of the alcove. Install electrical outlets, switches, and overhead lights. The apron at the top is ideal for a 48-inch fluorescent fixture. Build the framework, then cut the rest of the paneling to size and install throughout, being sure to use inside and outside corner molding where panels meet at 90 degrees.

To install the ceiling, the lip of the perimeter support-angle pieces should be at least three inches below the lowest duct or pipe to allow enough room for you to insert the tile after the support grid is up. However, even if there are no projections, you should allow six inches of free space below the joists.

To show the position of the perimeter support-angle pieces, snap a chalk line (with the aid of a helper) around the room at a height that will allow inserting the tiles without interference. Use a level to be sure the line is perfectly horizontal all around.

Now install the support-angle pieces. Plan to run the main hangers of the system at right angles to the joists so as to avoid having to bridge between them. Install the hangers and tile.

In our example, the ductwork for the heating and cooling system of the house was extended and vented into the new family room. Air conditioning helps keep the new addition dry. In addition, an exhaust fan was installed to keep moisture and temperature-related expansion and contraction of the paneling to a minimum.

Once you've installed your flooring, you will be ready to move in your furnishings—and start living more spaciously. PS

The materials for this project were supplied by these companies: *Paneling:* Woodfield Design paneling, Masonite Corp., 29 N. Wacker Drive, Chicago IL 60606. *Furniture:* Marin County Collection upholstery and occasional tables, Composite Collection party table and chairs, desk, Riverside Furniture Corp., Fort Smith AR 72902. *Ceiling:* Cumberland Pattern acoustical ceiling, Armstrong World Ind., Lancaster PA 17604. *Carpeting:* Form III, North Vernon IN 47265.

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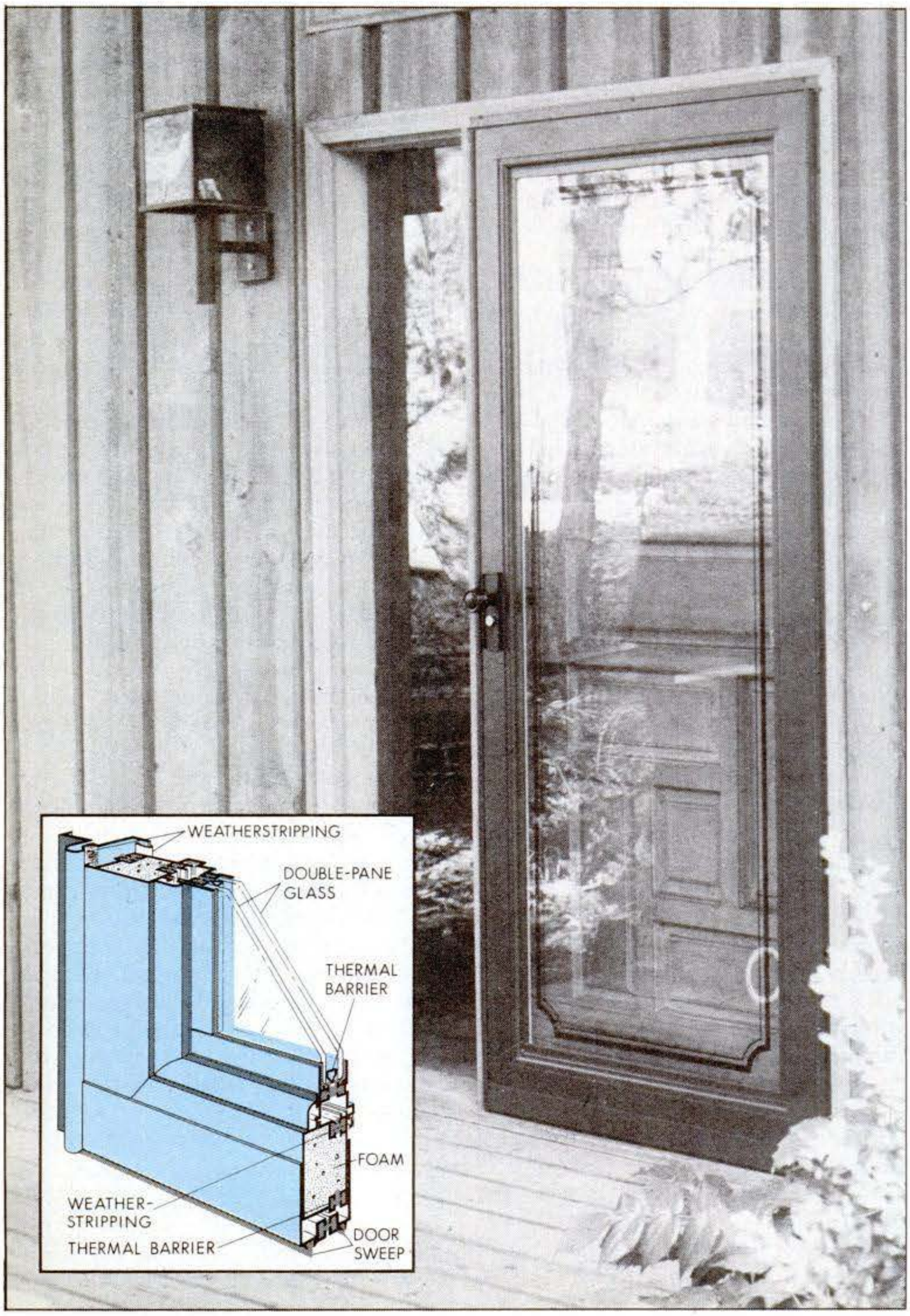
Block entry heat loss—

hang a super storm door



Handsome double-pane storm door from JCPenney (left) gives full view despite extra insulation. The window is sealed, double-pane glass (inset); foam insulation fills door panel and frame. Plastic thermal barriers isolate inner frame and window panel from outer frame, reducing heat loss even more and preventing the chilling and condensation often found with conventional storm doors. Finally, the door is sealed with both vinyl and pile weatherstripping.

Measure height of door opening before cutting storm door to size. It must be cut at an angle to conform to slope of existing door sill, so you need two measurements: the height of frame at outer edge (shown; make it "A") and at its inner edge near the door ("B"). Existing frame may be out of square, so measure both sides. Transfer measurements to storm door frame after removing glass.

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Keep heat in and drafts out with a heavily insulated storm door

By EVAN POWELL

Did your parents' home have a storm door? Probably. Long before the energy crisis, most homeowners felt the need for a double barricade against drafts. It took high fuel prices to make us appreciate how the common storm door also insulates by creating a dead-air space that blocks heat loss.

Only trouble—the common storm door often feels and looks flimsy. After a few years of use, even the more expensive versions tend to loosen, losing their sealing qualities and developing unpleasant metallic rattles. It's not unusual to find 1/16-inch gaps around the sides and tops of these doors. In terms of air infiltration, having such gaps can be compared to having a four-by-four-inch hole in your wall.

The solution? Install an uncommon storm door: a premium, super-insulated version. I chose JCPenney's Thermal Barrier Storm Door because of its unique insulating design (see diagram on facing page). Double-glazed, foam-filled, and weatherstripped with both vinyl and felt, this door is a formidable barrier against the cold.

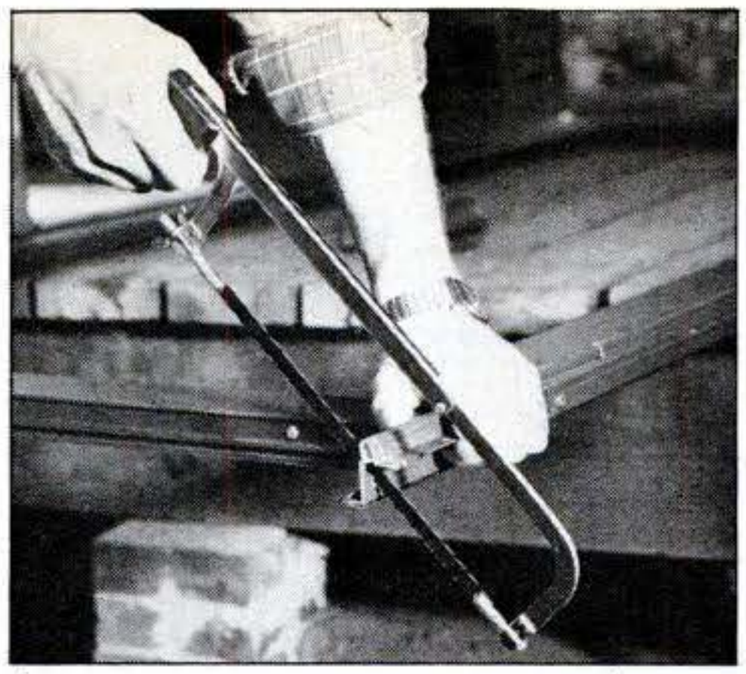
Besides reducing heat leaks, the insulation makes the door rigid, quiet, and solid. Even with its full window, the model I used is the most solid-feeling storm door of any I've encountered.

The special construction really works, according to JCPenney. Based on tests performed by an independent lab (Associated Laboratories, Dallas, Tex.), JCPenney says the door offers 45 percent better heat retention and cuts drafts twice as well as a standard steel door. (For half-window models, JCPenney's figures are higher: heat retention, 75 percent; air-infiltration reduction, fivefold.)

All of this costs, however. The model I bought sells for $289.99 in the JCPenney catalog; half-windows are $20 less.

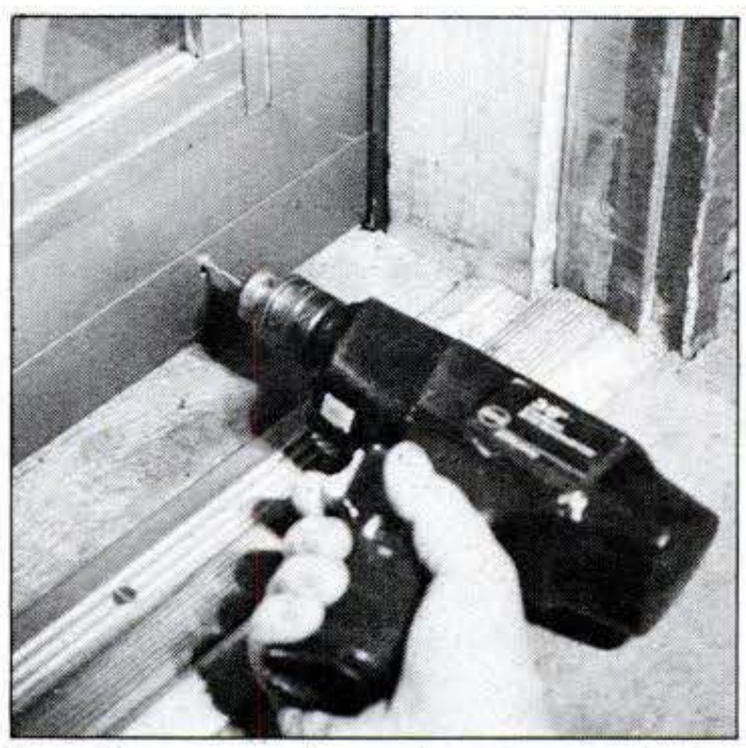
That's still less than the ones quoted to me by several installers of good-quality storm doors. As the photos show, the JCPenney door lends itself to homeowner installation.

Incidentally, you'll need someone to help handle the heavy glass insert, especially if you choose the full-view door. And be careful of the metal finish: To prevent scratches, use a blanket or the shipping carton to support the frame while you work. PS



Cut storm-door frame with a hacksaw to match sill angle. First mark point A and point B on back of frame, then draw each line around to the front side. Next, draw a diagonal line connecting point B on the back to point A on the front. Turn frame face up and cut on marked line as shown. Remove burrs with file.

Power screwdriver hastens installation, but be sure to use slow speed. You need a 3/32-inch bit to drill pilot holes in existing door frame. Predrilled holes in metal frame serve as a guide. If gap between latch side of the metal frame and the existing frame is more than 1/8 inch, it should be shimmed with a wood strip.



Installing expander at door bottom is the final step. Vinyl door sweep (attached to expander but not visible in photo) can be adjusted to touch the sill for an almost airtight seal. But if the primary door is already tightly sealed, the storm door may be hard to open. Raising the sweep solves that problem.

Piston engine for home heat?

It might make more sense to install an internal-combustion engine in your furnace room than under the hood of your car. So says a trio of General Motors researchers, who recently released a study showing that a hybrid system comprising a piston engine, heat pump, and motor-generator set would cut home-heating costs by about 50 percent in any climate.

The proposed system is similar to Fiat's Totem co-generator [PS, Aug. '77 and April '81], but its smaller engine and use of a heat pump make it suitable for single-family homes.

The GM system would be powered by a 10-hp engine fueled by natural gas or fuel oil. The engine would drive both the heat-pump compressor and motor-generator. Meanwhile, waste heat from the engine would be recovered by passing the engine coolant and exhaust gases through heat exchangers in the hot-water tank and space-heating air ducts. Thus, this system would use energy that is normally wasted in auto engines.

Other advantages over conventional home-heating systems come from the use of a heat pump, the most efficient supplier of space heat, and the bonus of surplus electricity. Most of the output of the electric generator would go to run the heating-duct blower and heat-pump condenser fan, but any excess would be available for other household demand or for feeding back to the utility grid.

The total system would operate only during the heating season, because the economics are based on the use of the waste engine heat. Although some of that energy might be useful for water heating during the summer, some could not be used—and that would kill the system's efficiency advantage. The heat pump and water heater would run off utility-supplied electricity in the summer.

Even so, the approximately $1,200 additional initial cost of the hybrid system over a conventional furnace would be justifiable for many of us, the researchers say. Their detailed computer simulation of energy use for homes in 10 different cities showed that, compared with conventional systems, the hybrid system would reduce total annual energy costs—including electricity—by up to 35 percent in cold climates, 20–25 percent in moderate climates, and 10–15 percent in warm climates.—*D. Ruby*

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Can you pick the duds? Here's how to shop for quality **plastic plumbing**

Which type for what use? An expert's tips will keep you out of trouble

By RICHARD DAY
PHOTOS BY THE AUTHOR

Sorting carefully through the bins of plastic pipes and fittings in the plumbing section of a large department store near Detroit, I selected these items to put into my shopping cart: a short-shot pipe plug with half its threads unformed; a toilet flange flashed so badly that it wouldn't sit level on a floor; two drainage elbows with internal ridges that could stop up wastes; and a Y with internal recesses.

I felt sure the checkout clerk would reject the short-shot. It was so obviously unusable that anyone would have noticed it. But if she did, she said nothing. The short-shot was rung up on the cash register with all the rest of my faulty fittings.

I can't really blame the clerk, though. The bad parts should have been tossed out by the manufacturer, the distributor, or the store's buyer. But no one cared enough. If I hadn't known better, I might have used them in my home's plumbing system, later wondering what I did wrong.

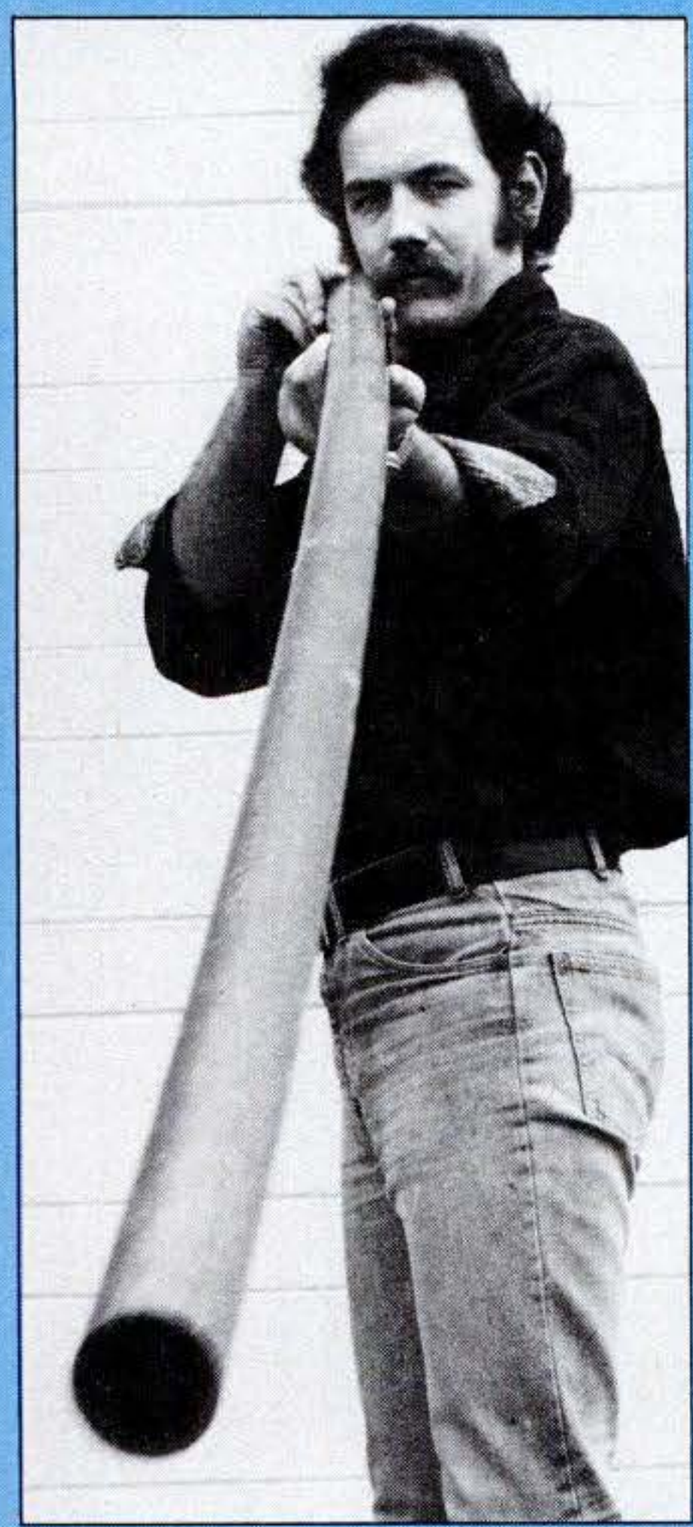
This experiment confirmed my suspicions: Shopping for plastic plumbing products is like buying fruits and vegetables in a produce market. *You* must be the inspector. It is you who must reject the bananas with the soft spots, the broccoli with the too-large stems. If you pick and choose, you can end up with quality. Otherwise, you may end up with a mess.

Plastics, properly used, are great plumbing materials. They are easy to install. They don't corrode, as metal pipes do. And no flame is needed to join them.

But it isn't quite as easy as it sounds. There's a huge variety of types and materials of plastic plumbing, and choosing the proper one for a particular use can be tricky. A table on the next page gives the vital statistics for each material.

Water-supply piping can be divided into two groups: pipes able to handle hot water under pressure and cold-water-only pipes. Chlorinated polyvinyl chloride (CPVC) and polybutylene (PB) are the only plastics suitable for hot-water supply tubing. CPVC is a rigid plastic; PB is flexible. PB is sometimes promoted as a universal water-supply tubing, but it is at a great disadvantage where many fittings are needed. Use CPVC in applications where the lines run straight

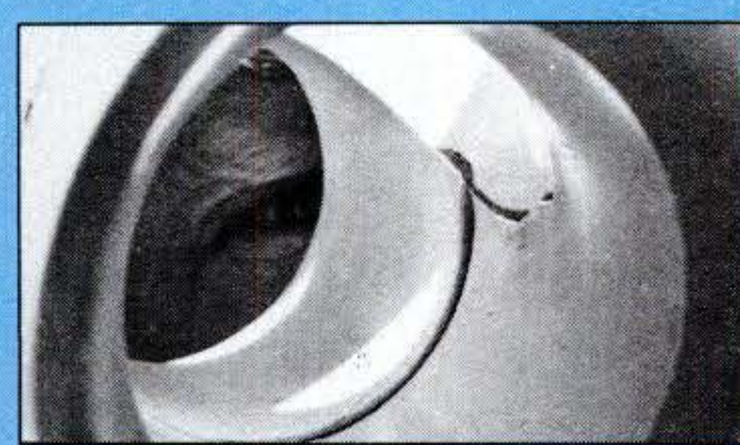
A gallery of faulty fittings



Waste and drain pipes must be installed at exact slope. Badly curved pipe would create low spot, impede flow.

Upper CPVC water-supply pipe is marred by a full-length extrusion line. Solvent-welded joint made with it might leak.

Which spigot fitting would you choose? You'd have to fully remove price sticker (left) off weld surface or risk bad seal.



Close look at inside of PVC Y shows deep recesses caused by worn-out mold. This weakens fitting wall, could trap wastes.

Exterior flash harms only fitting's appearance, but it should tip you off to manufacturer's poor quality control.

Scuffed and flattened pipe end, caused by dragging on ground, will prevent good seal. Always inspect pipe ends.

and PB where you need to run a line around corners without fittings (see table, page 114). To couple the two types of supply pipes, you'll need a brand of fittings that offers CPVC-PB adapters.

Polyvinyl chloride (PVC) and polyethylene (PE) are made as pressure lines, too, but neither material will take hot water under pressure. Don't use them in the house. Rigid PVC and flexible PE are most useful for underground plumbing, in irrigation and sprinkler systems. PE pipe is also good in well casings.

The same two plastics are among several others used for less-demanding sewer, drainage, and drain-waste-vent piping. PVC and acrylonitrile butadiene styrene (ABS) are the most common drain-waste-vent and sewer-pipe plastics—ABS chiefly on the West Coast, PVC everywhere else. PVC drain-waste-vent and sewer pipe is made in Schedule 30 and 40 ratings. They are the same size inside, but Schedule 30 has thinner walls so it is smaller outside. It is sometimes referred to as "in-wall" pipe because a three-inch Schedule 30 pipe (the only diameter manufactured) with its fitting hubs will slip into a standard 2×4 wall. To accommodate same-size Schedule 40 fitting hubs, the house wall would have to be furred out.

PE is also used for sewer and drainage pipe, or as a combination. The combination pipe may carry wastes, but not inside the house. Rubber styrene (RS) is another material often used for subsoil drainage piping.

The plastic plumbing material with the greatest heat and chemical resistance is polypropylene (PP). This plastic takes heat so well that it is used to

[Continued on page 114]

Plastic-plumbing materials

Material	Its uses	Color	Joining method
Polyethylene (PE)	Flexible cold-water pressure lines, buried or in well casings; made in various strengths; not for hot-water or indoor use; made in iron-pipe sizes	Black	Barbed clamp couplings
Polyvinyl chloride (PVC)	Rigid cold-water pressure lines buried in ground; not for hot-water use; also used for rigid drain-waste-vent, subsoil sewer and drainage piping, and fixture traps; water tube comes in iron-pipe sizes; DWV and sewer pipes come in Schedules 30 and 40; drainage pipe comes in Schedule 30	Beige; also made in many other colors	Two-step solvent welding
Chlorinated polyvinyl chloride (CPVC)	Rigid hot- and cold-water pressure lines indoors and buried; comes in copper-tube sizes	Beige; sometimes colored black or gray	Two-step solvent welding
Polybutylene (PB)	Flexible hot- and cold-water pressure lines indoors and buried; comes in copper-tube sizes	Beige; sometimes colored black or gray	Mechanical couplings
Polypropylene (PP)	Tubular drainage products for fixtures—traps, etc.; most resistant to heat and chemicals of all plastic-pipe materials	Beige	Slip-jam-nut couplings
Acrylonitrile butadiene styrene (ABS)	Rigid drain-waste-vent and sewer piping, chiefly on West Coast; also, fixture traps and slip-jam nuts	Black	One-step solvent welding
Rubber styrene (RS)	Rigid subsoil drainage piping	White, milky, or black	One-step solvent welding

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PS leisure-home plan

Passive-solar wing

for a year-round spa

Cutaway view shows how spa wing relates to rest of house: Walled off from the great room, it features direct access from the master bedroom. Roof above it sports three fixed and three openable skylights for solar gain and ventilation.

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By AL LEES

The trend continues toward equipping leisure homes with special amenities, since most second-home owners quickly find that they not only do most of their own relaxing there but that the country retreat also serves for most of their entertaining. So the whirlpool spa—an outgrowth of California's hot-tub movement—has been added to more and more leisure homes. It's an ideal rejuvenator after a week of on-the-job stress, and it's a stimulating option to offer weekend guests.

Ken Gephart of Home Building Plan Service (in cooperation with the Western Wood Products Assn.) designed this handsome home *around* a spa, giving it its own passive-solar wing. A masonry-tile floor soaks up and retains heat from the sunlight that pours through the glazed corner of the spa and through its skylight-pierced roof.

On guestless weekends—particularly in cooler months—you'll appreciate the spa's direct access from the master bedroom. Your guests, on the other hand, will applaud the spa's convenience to the large public deck—ideal for sunning after a soak.

Even when it's not in use, the spa wing functions as a passive solar collector. The heat it soaks up during the day can be directed into the rest of the house at night by opening and closing doors. The wood stove's two-story masonry shield also collects and distributes heat.

Another novel feature of the house is the way the great room thrusts itself forward of the floor plan's basic rectangle to become a virtual solarium, with three glass walls. This thrust also delineates the activity areas of the wraparound deck, as shown on the plan—each with its own direct access through sliding glass doors. An ideal area for alfresco dining lies just outside the more-formal dining room.

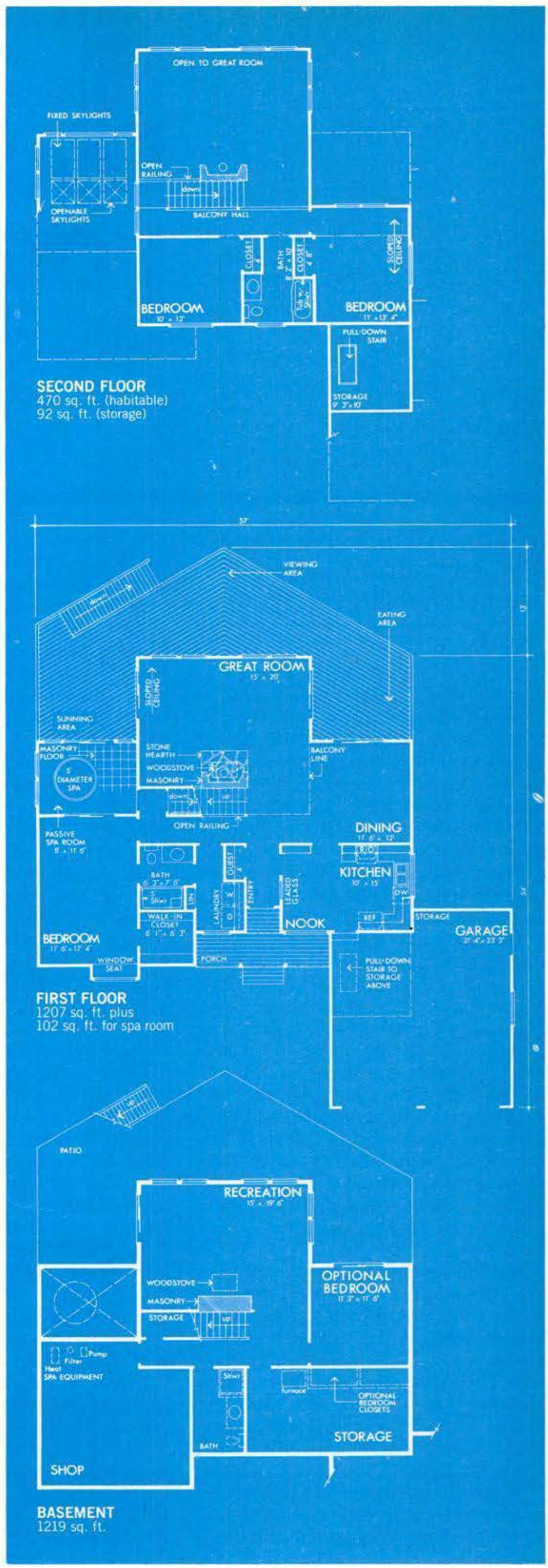
Note that nearly the entire great room is open to the second floor, with the open railings (seen in our cutaway) letting the balcony hall share the view.

Picture the drama of entering from the "street" door (which sports its own sheltered porch) and emerging from the entry hall, past that towering masonry shield and into the soaring space beyond—the down-swoop of the cathedral ceiling focusing your attention on the view beyond the prow of the deck.

The ground-floor master bedroom offers a walk-in closet, a cozy window seat (from which you can check for arriving guests), and private access to a walk-through bath; you'd simply step across, on entering, to latch the opposite door to the utility alcove. This arrangement lets the bath serve as a guests' changing room for the spa, while preserving the bedroom's privacy.

Naturally finished board siding is applied vertically to give an added "lift" both inside and out.

Plans are offered with or without a basement. On a sloping site like the one shown, a daylight basement can be notched into the earth to add the optional space shown in the bottom floor plan. PS



How to order your plans

One set of professionally drawn plans for this house is $100; four sets (for construction, financing, filing for permits) are $140. Specify plan number 952-1A (without basement) or 952-1B (with basement). Mirror-reverse plans are available—specify how many sets in your order are to be reversed. Materials list is $20; typical plumbing and wiring diagrams are $7.50 each. Add $5 postage to all orders. To use MasterCard or Visa accounts, call toll-free (800) 547-5570 (for plans orders only). Or write to Home Building Plan Service, 2235 N.E. Sandy Blvd., Portland, Ore. 97232-2884.

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THE THINKING MAN'S GUIDE TO CAR MAINTENANCE

By JACK KEEBLER

Soundproofing your car

for a whisper-quiet interior

Tired of your noisy auto? You can make it quieter with some simple steps

You bought an expensive sound system for your car. It sounded great in the hi-fi shop, and was still impressive when your car was sitting in your driveway after the system was installed. Then you took the car out on the road. Above 35 mph, much of that expensive sound was drowned out by road noise.

Your soft-spoken Uncle Melvin flew in for a visit and you drove him on a tour of your part of the state. But conversation grew strained when you couldn't hear half of what he was saying, and you found your throat raw from shouting. The villain: road noise.

Can anything be done to keep outside noises outside, and limit inside sound to conversation or your sound system? Happily, the answer is yes.

With the right materials and know-how, any car owner can seal off the passenger compartment from the sources of unwanted noise: the propulsion system, tires, and the wind.

There are four major areas you can deal with:

- The easiest, cheapest, and most effective single noise-control step is to make sure the window glass seats snugly against the rubber weatherstrips.
- The next step is to make sure that all holes in the fire wall are closed with either the proper replacement grommet or an expanding polyurethane foam.
- Adding mass to body panels and fender wells with either an asphaltic or rubber-based spray-on sound deadener will also reduce sound levels.
- The most difficult and expensive method is to use sound barrier and absorption materials to line the passenger-compartment interior.

Most manufacturers do an effective job of controlling vehicle noise. But perhaps you're more sensitive to your car's sound levels than the average buyer, or maybe age and weather have taken their toll on your car's sound-control parts. The main path of sound transmission from the outside is by way of the windows. When the windows are up, the glass usually does a good job of attenuating outside noise. However, if door and window seals are not in good condition, they're probably letting noise leak in.

Although GM inspectors use stethoscopes to find wind leaks, a length of rubber hose would work for you. With someone else driving, put one end of the hose to your ear, and run the other end along suspected surfaces.

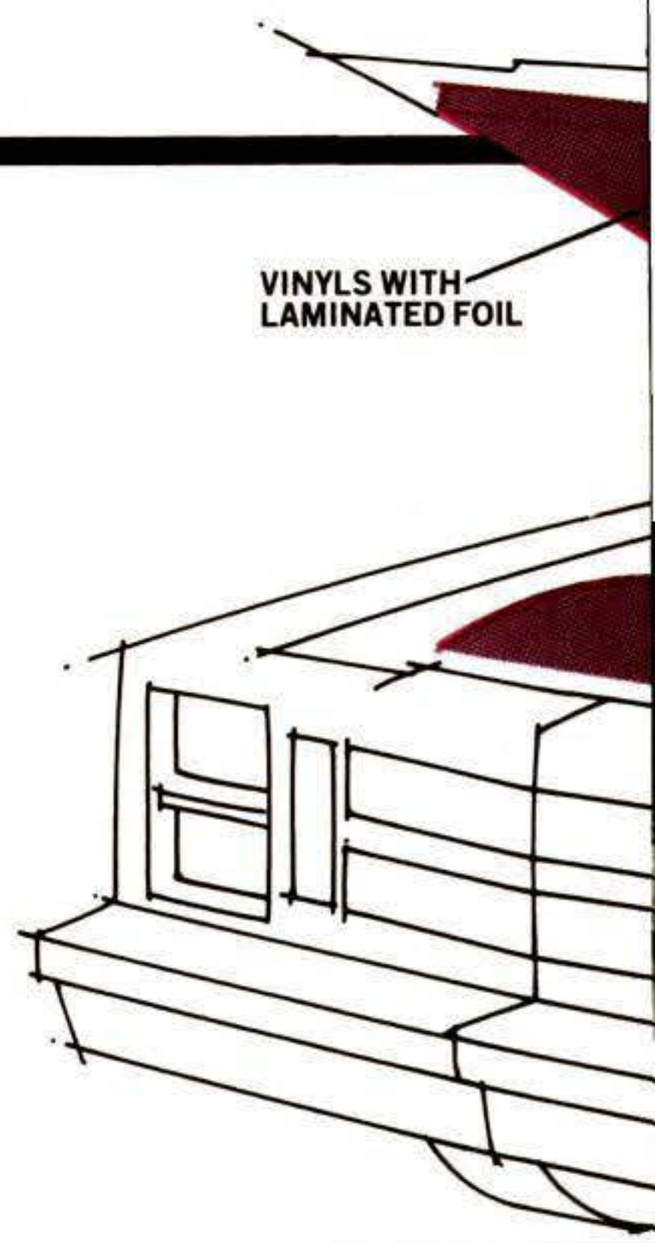
Uninvited wind noise can also enter via the windshield molding. To find leaks here, pour liquid soap over the section in question. Then, from inside the car, carefully apply compressed air along the edge of the glass, using an air hose. (Do *not* use over 30 psi.) Bubbles will form at the leak.

I've found that a clear silicone sealant spread carefully and sparingly along both sides of the molding usually seals the area without the hassle of having to remove the molding to reseal the pillar.

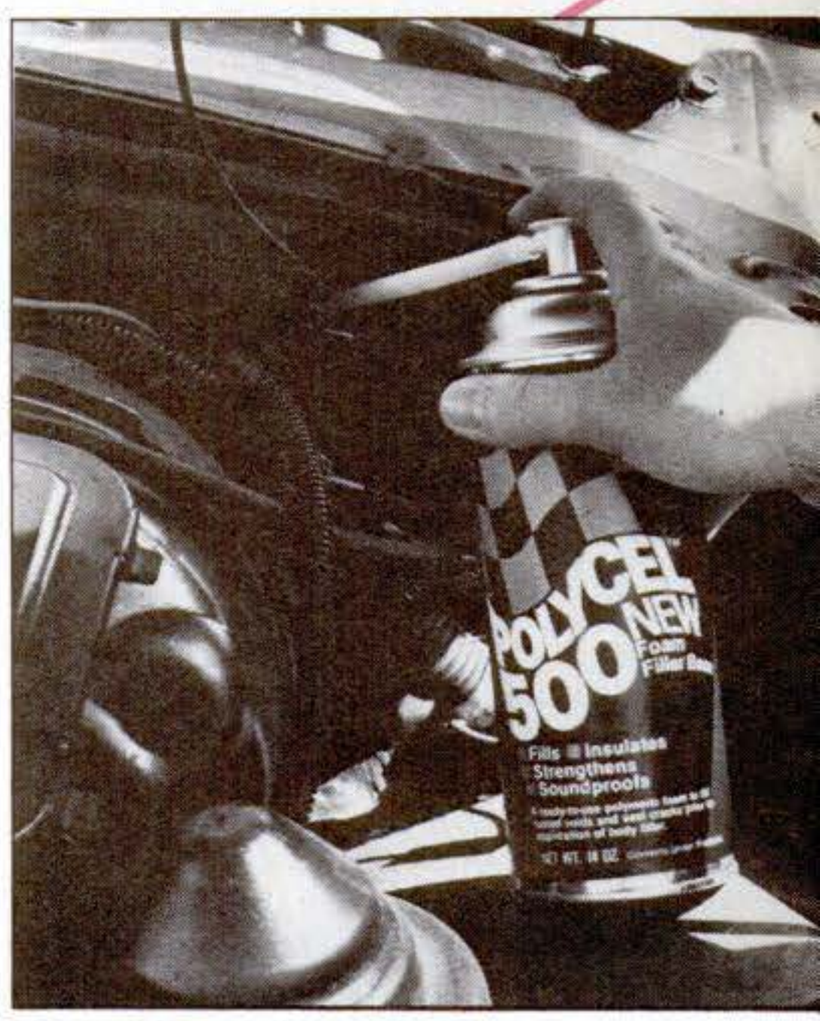
I recently gathered a large group of soundproofing products to try out on my car. Here's what I learned.

Urethane-foam sealants. I sprayed these aerosol-type foams directly into openings in the fire wall and body panels. A small quantity sprayed around cables and pipes expands and

Continued



DRAWING BY RUSSELL VON SAUERS



FIRE WALL: AEROSOL FOAM

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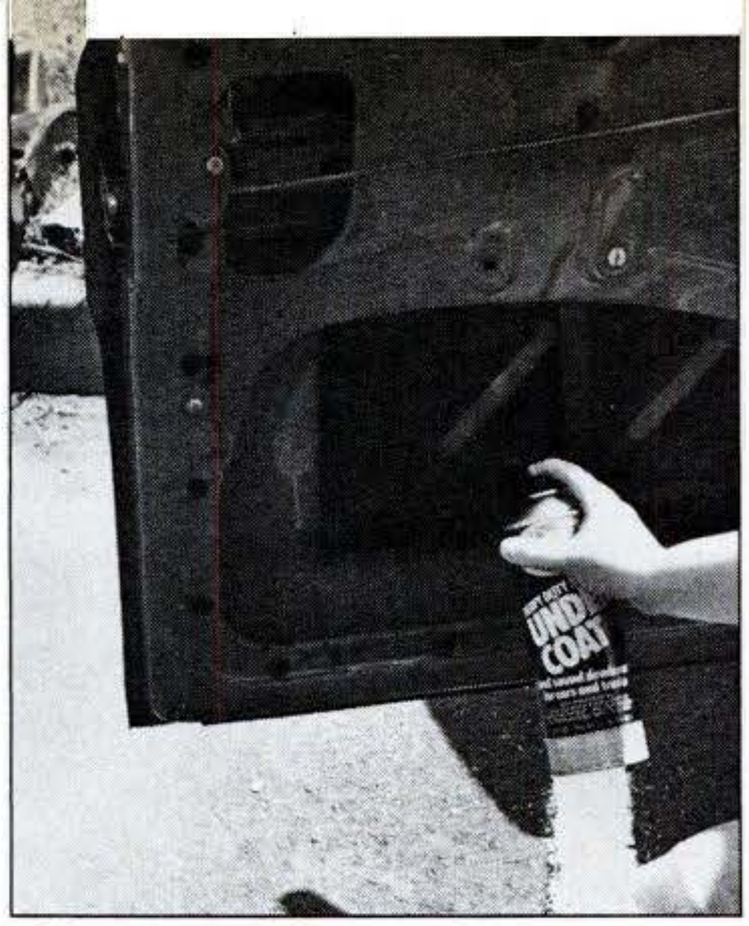
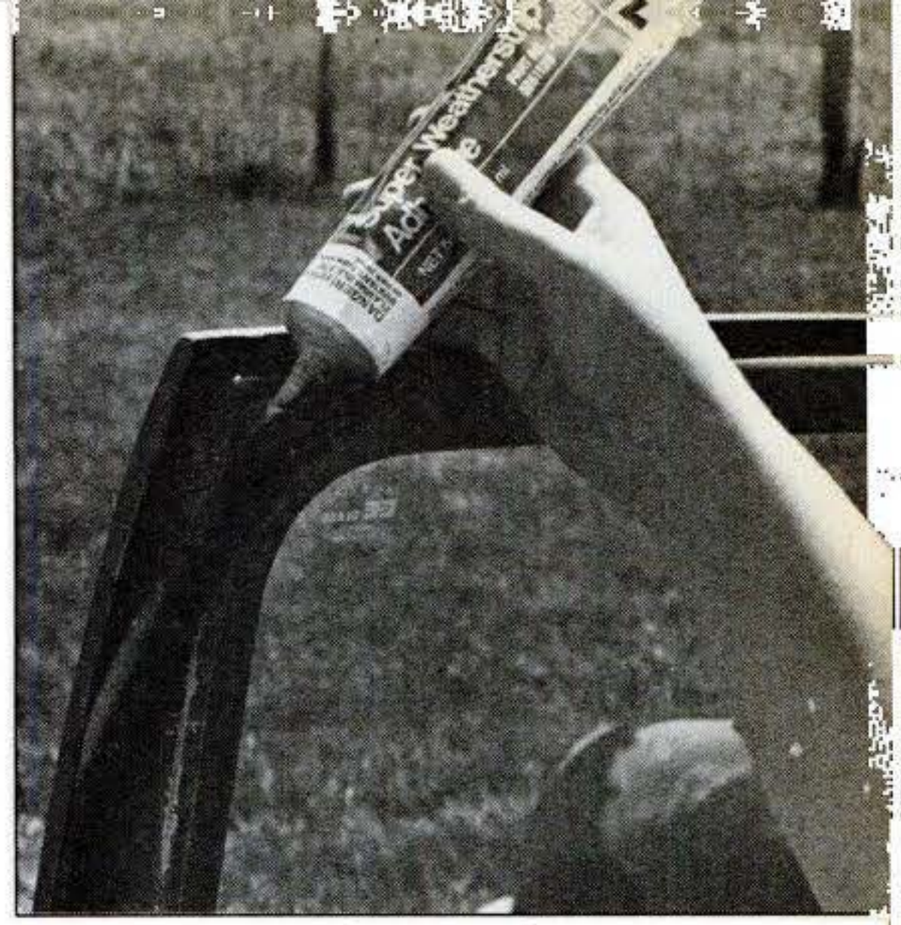
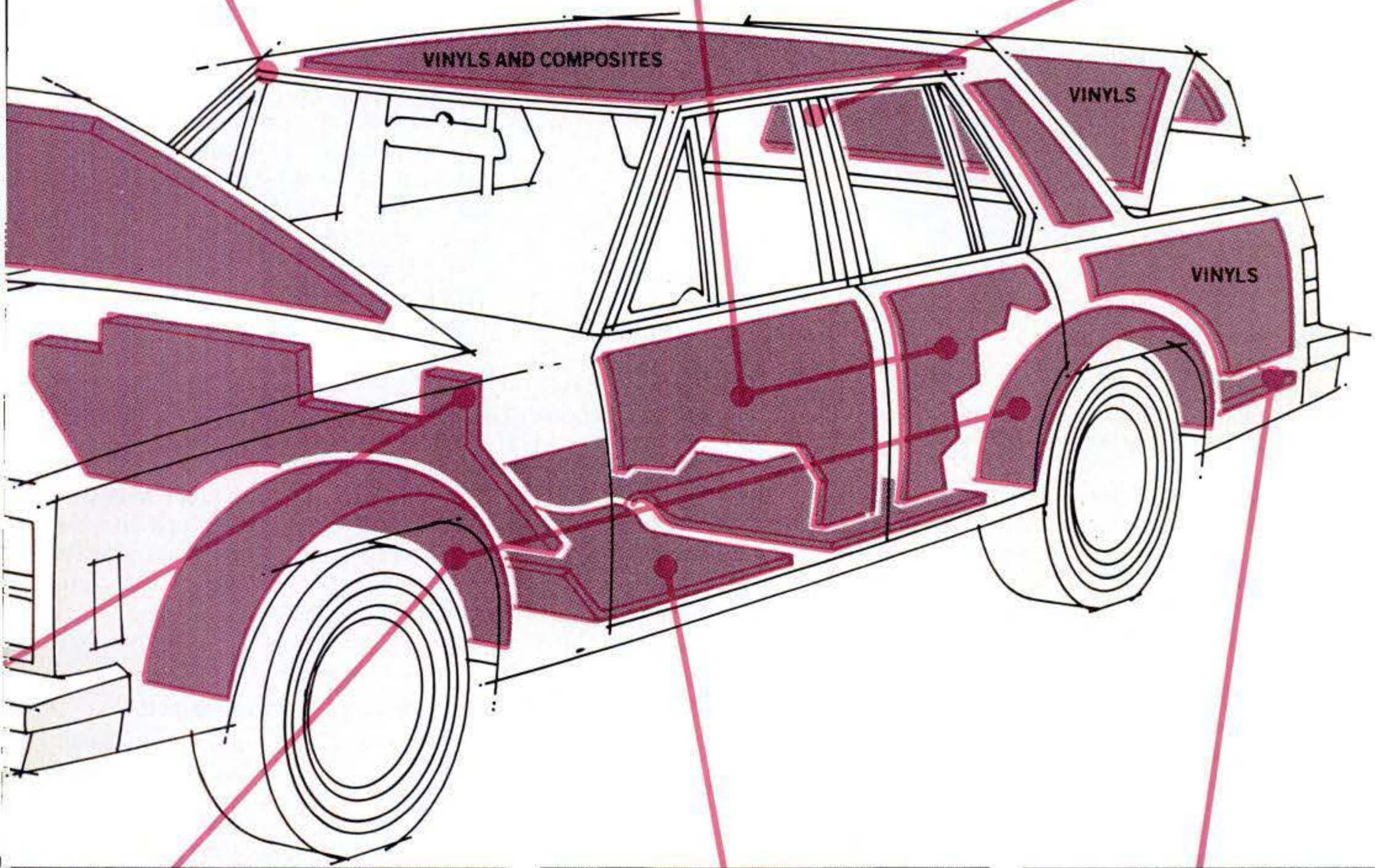
WINDSHIELD: SILICONE SEALANT

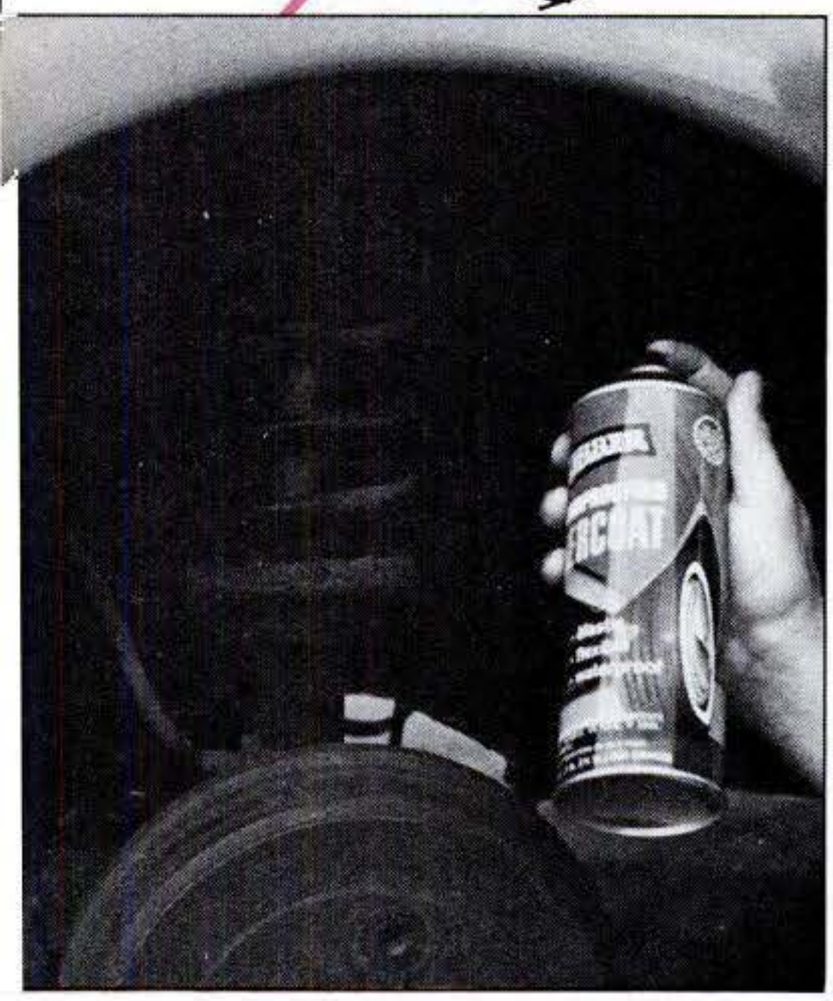


DOOR PANEL: ASPHALTIC SPRAY

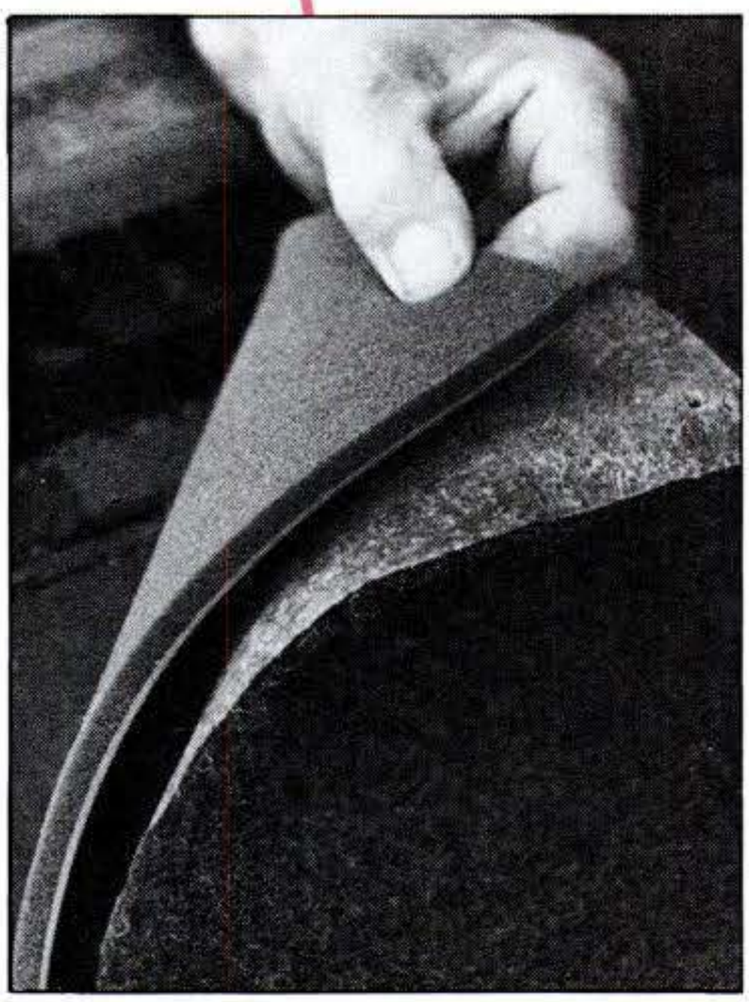


DOORS: WEATHERSTRIPPING ADHESIVE

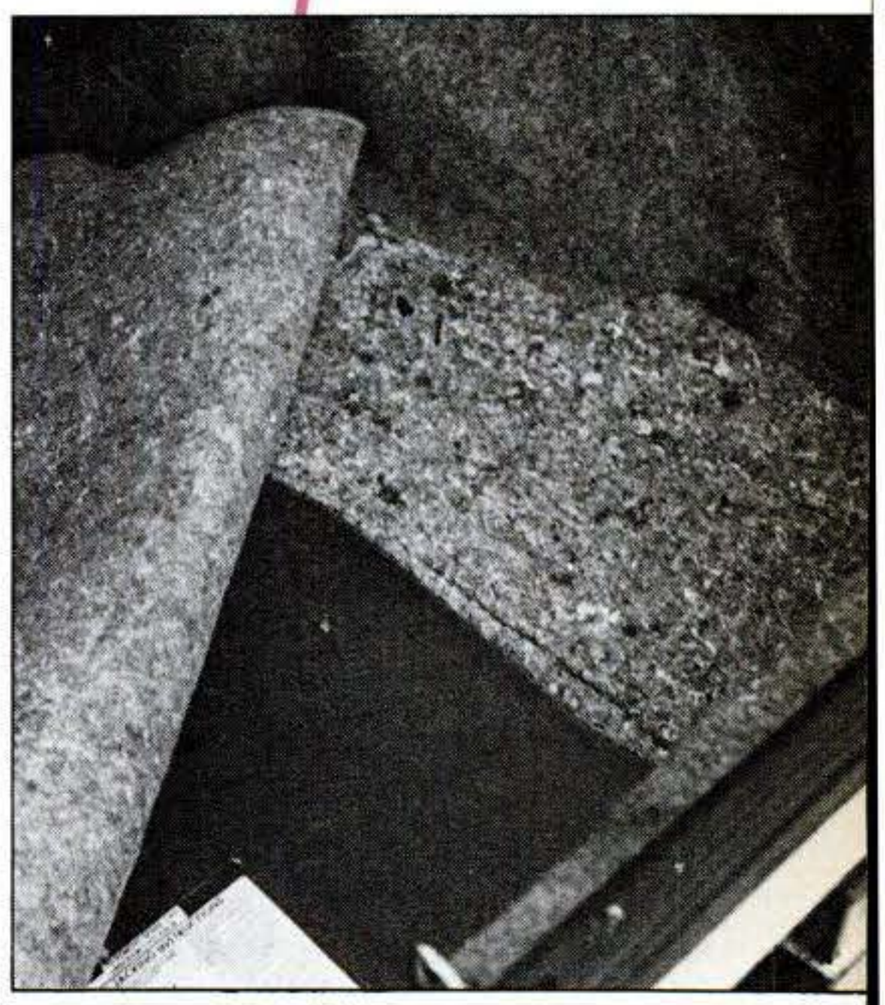




WHEEL WELL: RUBBER-BASE SPRAY



CARPET UNDERLAY: COMPOSITE



TRUNK: WASTE-COTTON BLANKET

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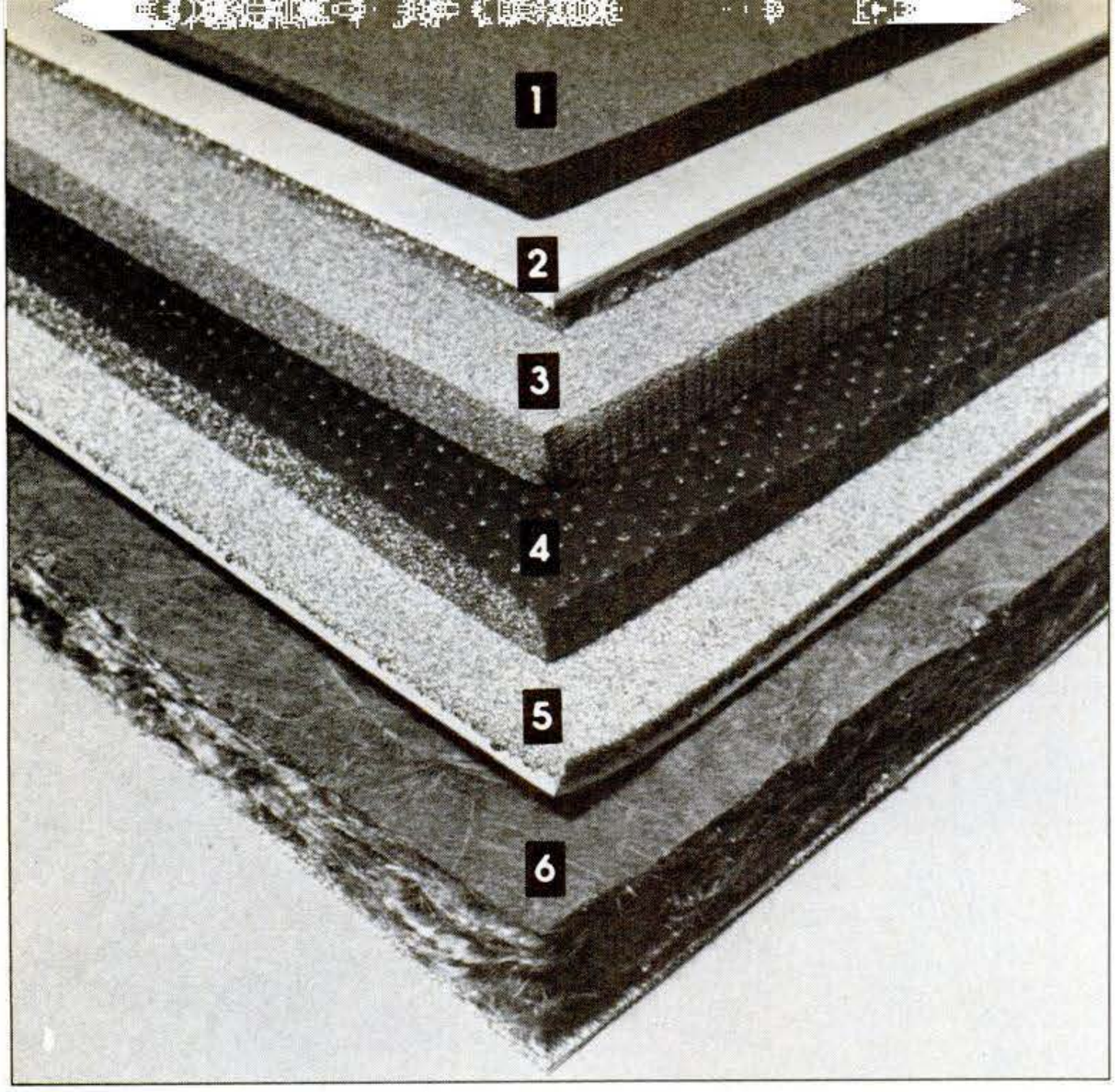

Soundproofing blankets: (1) foam, Uniroyal (general purpose); (2) composite, American Acoustical Products (carpet underlay and fire-wall liner); (3) foam, Uniroyal (general purpose); (4) perforated vinyl composite, American Acoustical Products (interior trim and headliner); (5) composite, American Acoustical (trunk liner); (6) fiberglass composite, American Acoustical (fire-wall liner, engine side).

adheres to create a leak-proof seal. Since these foams have a tenacious grip, you should cover the areas not to be sprayed with polyethylene. Gloves and eye protection are recommended when using these materials.

Spray-on deadeners. There are two basic types of sprays—asphaltic and rubber-based. I sprayed the interior side of the passenger-compartment steel panels with the asphaltic spray after removing the door and quarter trim panels. (Refer to your car's panel-removal procedure in the repair manual so you don't damage the panel-retaining clips.)

I chose to spray my car's fender wells and underside with a rubber-based spray because it's more flexible, weather resistant, and elastic than the asphaltic sprays.

Caution: Don't spray moving parts, energy-absorbing bumper components, or any areas within 12 to 14 inches of the exhaust system.

Acoustical Materials. Closed-cell foams are a type of acoustical material whose greatest advantage lies in its light weight and moisture resistance. (The waste-cotton blankets used by most manufacturers are lightweight and effective, but they become sodden if water leaks into the interior.) I used Uniroyal's Ensolite foam on the backs of door and quarter trim panels. Cutting the foam to fit was easy. I laid the trim panel on top of the foam and traced around the edge with a piece of soft chalk, then cut along my mark with a pair of sharp scissors. I carefully cut holes through the foam for the window-crank shafts and panel-fastening hardware. Finally, I glued the foam inserts to the backs of the panels with an industrial adhesive. A spokesman for Uniroyal told me that it's important to select the proper adhesive. Since Ensolite is a nitrile-based foam, I used a nitrile-based adhesive. One-quarter inch of the foam as a decoupler and a sheet of vinyl should yield a noise-reduction coefficient of approximately 0.25 (see box).

TEMP-MAT by Pittsburgh Corning and Cousti-Therm by Ferro Composites are both lightweight, flexible, and highly temperature-resistant fiberglass blankets. I laid an inch-thick section of fiberglass insulation over the floor area above the catalytic converter and trimmed it to fit with a pair of scissors. If you decide to use this material, wear gloves to protect your hands. Pittsburgh Corning claims an NRC of 0.80 (see box).

Loaded vinyls are another barrier-type sound-isolation material. These special vinyls are impregnated with a dense material like a powdered metal. Vinyls are the most difficult to install of the materials I examined. First, you spray the steel panel or foam to which the vinyl is to be affixed with the manufacturer's thinner and adhesive. Allow it to air-dry for 30 minutes. Spray the surface a second time, allowing it to dry for eight hours after the new application. Brush about three mils of the manufacturer's adhesive on the steel panel. While both surfaces are still tacky, press the vinyl onto the foam or steel panel.

Composite underlays may be the best bet for the do-it-yourselfer. Composites are pre-bonded layers, usually of a barrier vinyl and a foam. Their sound-transmission-class numbers can range as high as 37 (see box). To install the material, I carefully removed the seats and carpets from my car and used the carpets as patterns for cutting out the composite underlay with a pair of scissors. The only area not covered by the underlay was the section of the floor above the catalytic converter. High temperatures above the converter require the use of fiberglass blankets, as already mentioned. Finally, I used an industrial adhesive that was compatible with the composite's foam and glued the underlay to the floor panels, foam side down.

Some manufacturers specify minimum quantities when you order their products. For sources, check the Yellow Pages under Acoustical Consultants, Acoustical Contractors, and Acoustical Materials. PS

Measuring performance

The two most important reference values for comparing *absorption* materials are the sound-absorption coefficient and the noise-reduction coefficient (NRC). A sound-absorption coefficient of 0.55 means that 55 percent of the incident acoustical energy is absorbed. However, acoustical materials don't absorb all sound frequencies equally well. While one material may absorb frequencies in the 2,000-Hz range with a coefficient of 0.99, it may absorb sound in the 250-Hz range with only 20 percent efficiency (0.20). Therefore, the materials are also assigned a noise-reduction coefficient. The NRC is a mathematical average of sound-absorption coefficients recorded at 250, 500, 1,000, 2,000 Hz.

When considering *barrier* materials, the important value to look for is the sound-transmission-class (STC) number. Even standard construction materials have some barrier value: A window with double glazing has an STC number of about 25. The STC number for a four-in.-thick brick wall is approximately 55.

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A pro's dozen

—12 great wood-shop tools you didn't know you needed (until now)

PHOTO BY THE AUTHOR

By THOMAS H. JONES
COLOR PHOTOS BY GREG SHARKO

You don't need a roomful of tools to do fine woodworking. When I started building furniture, I owned a pad sander, scroll saw, router, and bench-mounted disc sander. I won't try to explain the rationale for that particular selection, but I built both Sheraton and French Provincial roll-top desks with it.

When I build a piece of furniture, whether for personal use or on commission, my interest is in getting the job done right and doing it in the minimum time. Don't get me wrong; I enjoy woodworking—I just can't afford to squander time doing it. Consequently, tools I've added to my collection over the years have been chosen because they contribute to doing the woodworking better, or faster, or both. That hasn't always meant power tools—or, at least, *big* power tools. Sometimes, I've found, it pays to think small. And sometimes, even in this day, the right hand tool will do a job better than any power tool you might use.

Among the most useful hand tools and small power tools I've added to my woodworking collection are some unusual ones that many of you may not have tried. I've selected a dozen of my favorites and demonstrate them on the following pages.

For me, these tools range from very useful to downright indispensable. Each can give you a pro's edge in your woodworking and can make a fine gift for woodworkers on your Christmas shopping list. Most are available at relatively modest cost. Good mail-order sources for all of them are listed at left. PS

Turn page for wood-shop tools

Sources for woodworking tools shown

Brookstone Co., 127 Vose Farm Rd., Peterborough NH 03458; **Constantine,** 2065 Eastchester Rd., Bronx NY 10461; **Craftsman Wood Service Co.,** 1735 W. Cortland Ct., Addison IL 60101; **Dremel,** 4915 21st St., Racine WI 53406; **The Fine Tool Shops, Inc.,** 20-28 Backus Ave., Danbury CT 06810; **The Foredom Electric Co.,** Bethel CT 06801; **Garrett Wade Co.,** 161 Ave. of the Americas, New York NY 10013; **Frog Tool Co., Ltd.,** 700 W. Jackson Blvd., Chicago IL 60606; **Leichtung,** 4944 Commerce Pkwy., Cleveland OH 44128; **E. C. Mitchell Co., Inc.,** P.O. Drawer 607, Middleton MA 01949-0907; **Porter-Cable Corp.,** Jackson TN 38301; **Sears Roebuck** (any catalog store); **Shopsmith, Inc.,** 750 Center Dr., Vandalia OH 45377; **Woodcraft Supply Corp.,** 313 Montvale Ave., Woburn MA 01888; **The Woodworkers' Store,** 21801 Industrial Blvd., Rogers MN 55374.

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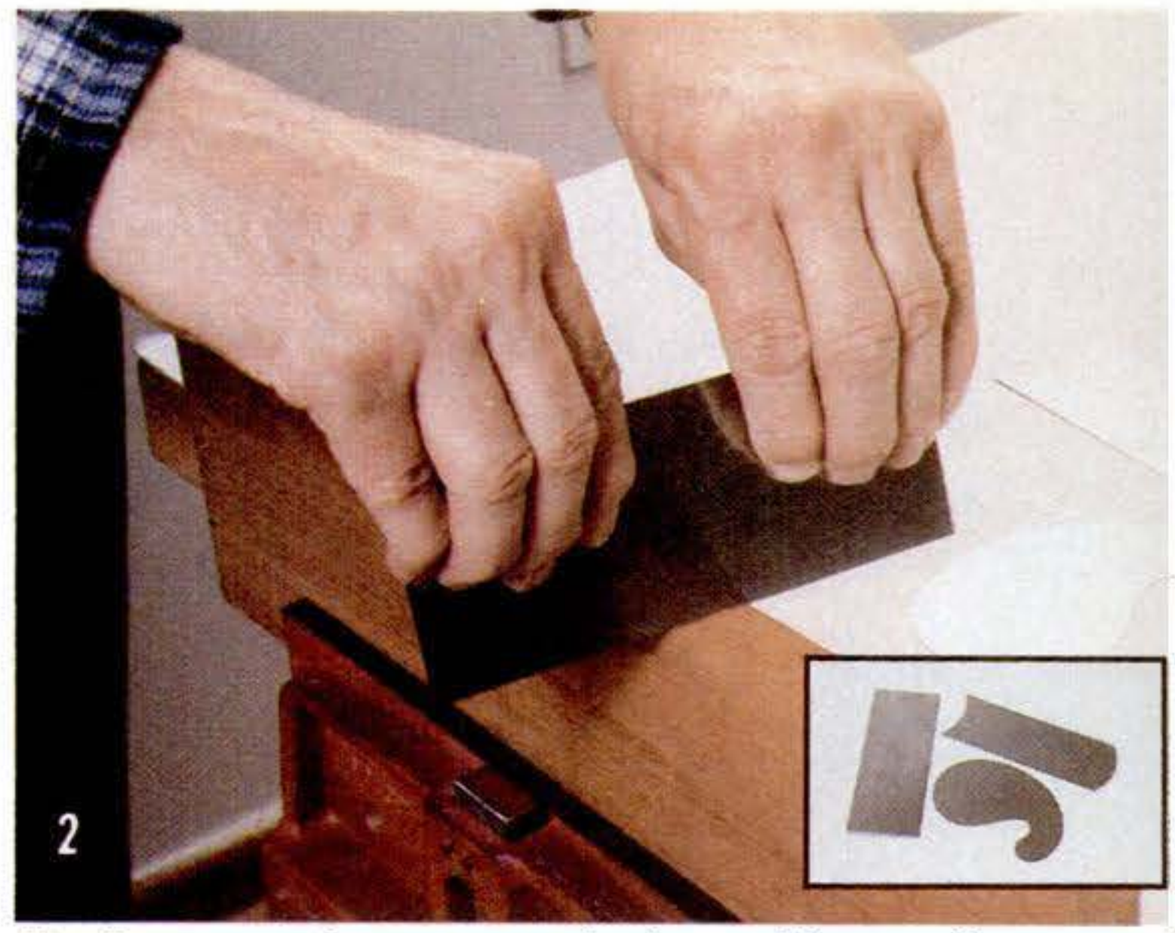
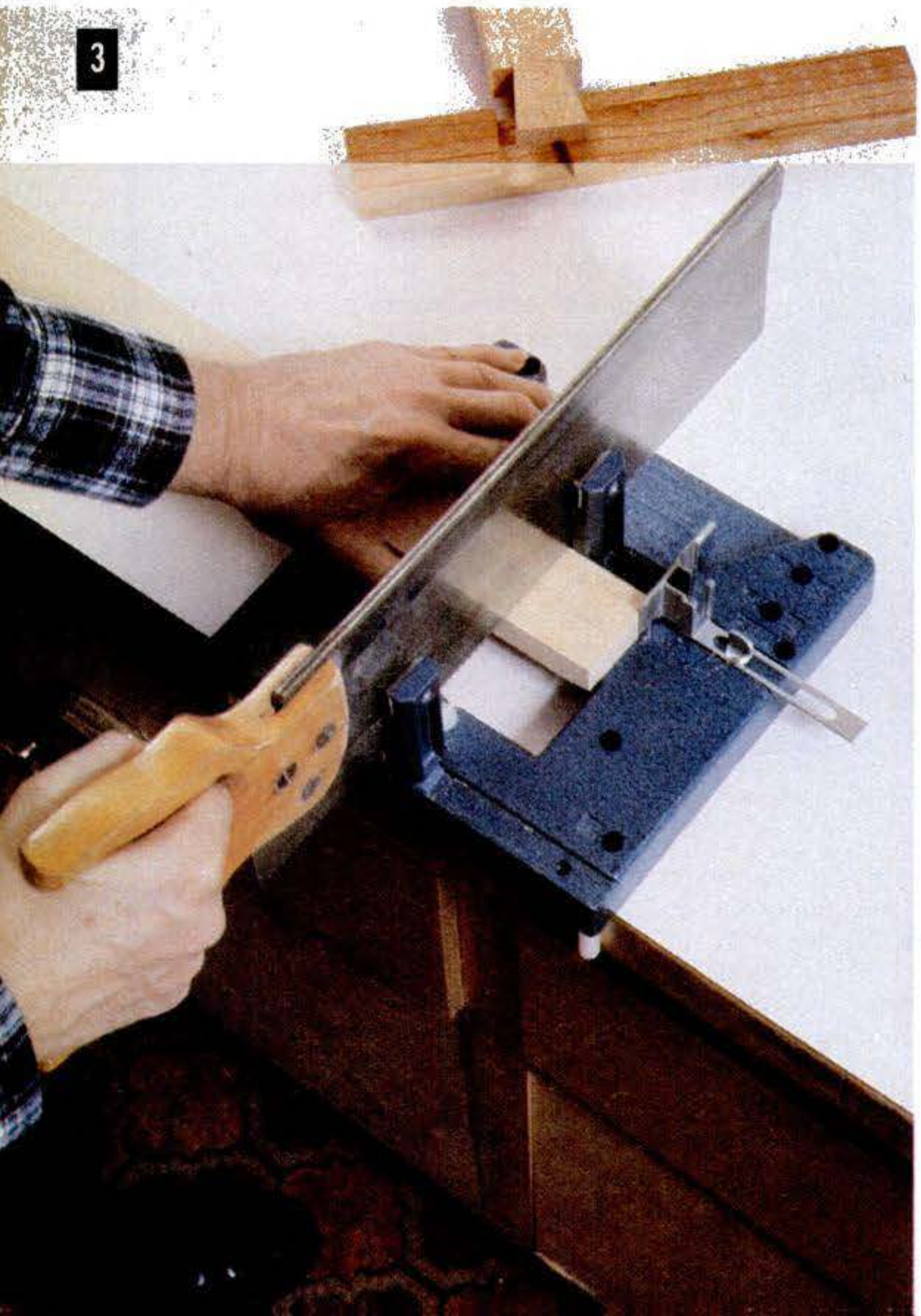
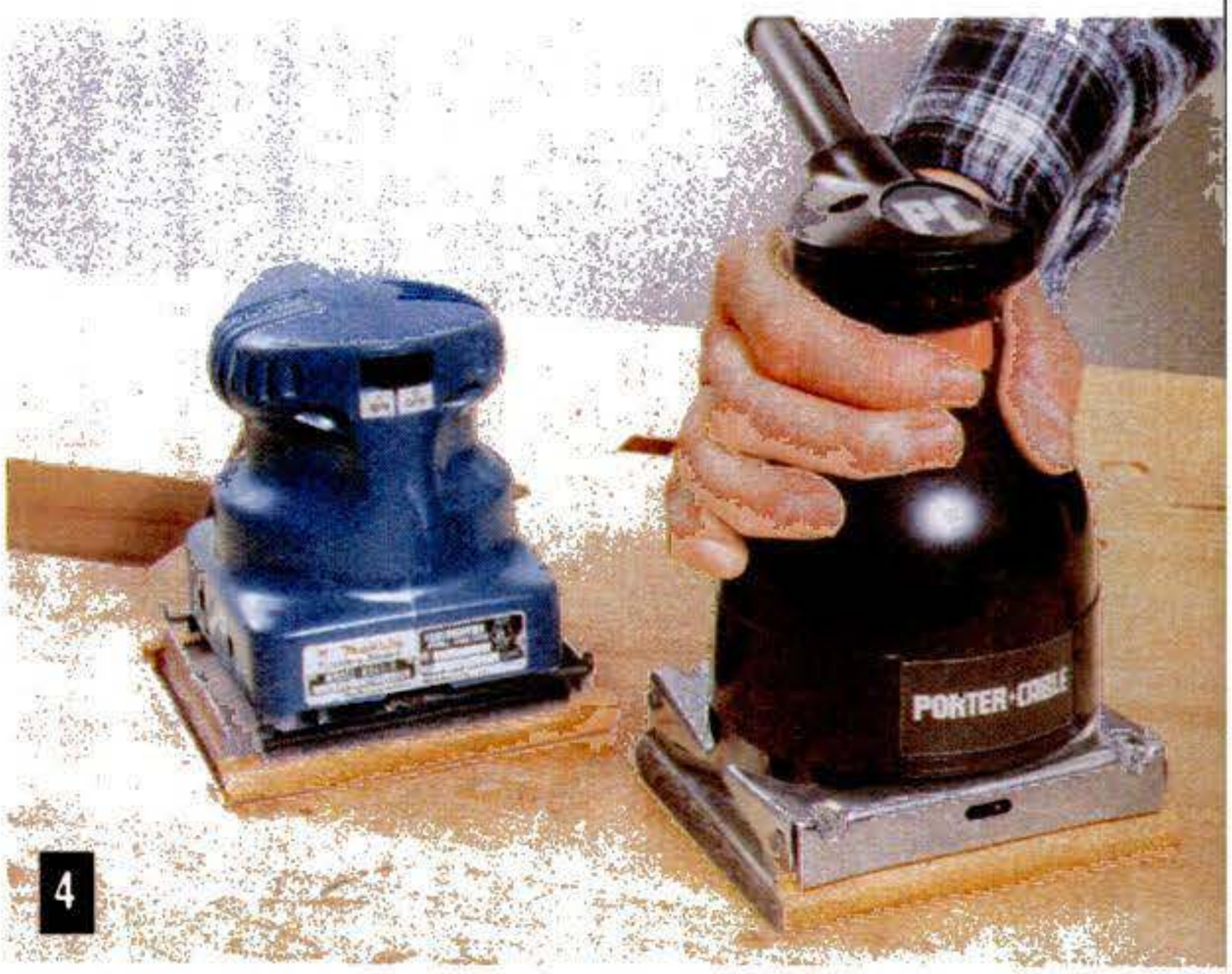
Dozuki saw, also called a tenon or dovetail saw, is efficient, easy to use, and accurate for light-duty work. Because it cuts on the pull stroke, the tensioned blade can be very thin—only 0.011 in., compared with 0.03 in. for a typical backsaw. The thin blade and 0.005 in. of set produce a kerf just over 1/64-in. wide. When sawing, you put the blade *on* the pencil line, without worrying about which side is waste. The very narrow kerf also makes for easy sawing because so little wood is converted to sawdust. With 18 teeth per in., the saw cuts very cleanly. The Dozuki is great for last-minute corrections, such as trimming 1/16 inch from a slightly long tenon. It's also a fast way of forming tenons, even if you have power tools, when you're making only one or two. Sharpening the very hard, closely spaced teeth on the laminated steel blade of a Dozuki saw is tedious, difficult, and requires a special file. Therefore, I like Garrett Wade's convenient replaceable-blade Dozuki saw. Cost: about $19; replacement blade: $9.



Hand scrapers: Once you get the hang of how to sharpen and use them, you'll wonder how you got along without one. A single scraper can be used for rough and finish work. Used after semi-finish sanding, a hand scraper can cut surface-preparation time in half. You can use a scraper for cleaning off dried glue and for shaving off even partially dry sags and bubbles in varnished surfaces. However, it should not be used for removing hardened paint; that would rapidly dull the edge. You can use a hand scraper to remove sander marks from a board edge without rounding the edge—an almost impossible task with a pad sander. But be advised: A new scraper is not ready to use. You must first file, stone, and hone the edge smooth, then put a burr on the edge with a burnisher. It's the burr, or hooked ridge, that does the work. Hand scrapers are sold, individually and in sets, by all tool mail-order houses. A typical three-piece set (see inset) will handle all surfaces except moldings and will cost you $6 to $8.





Copydex Jointmaster (left) is a precision-made sawing jig that will let you make a wide variety of wood joints by hand with close-to-power-tool accuracy. A selector head and adjustable bracket automatically gauge the width of 90-deg. joint recesses, with automatic compensation for the saw kerf. A handy wedge block provides an automatic eight-degree setup for making dovetail joints. Once it's set up, you can make multiple pieces without remeasuring. The Jointmaster is designed for a backsaw having minimal set. It's about $36 from Brookstone.

High-speed, small-displacement pad sanders (above) are a world away from conventional orbital/straight-line sanders. The motion of these two is orbital only, but the 12,000 orbit-per-minute speed and 1/10-in. pad displacement give swirl-free results. With fine paper you can get a near-mirror finish. You can move the sander with or across the grain. Porter-Cable model 330 Speed-Bloc is about $65; Makita's model BO4510, $70.

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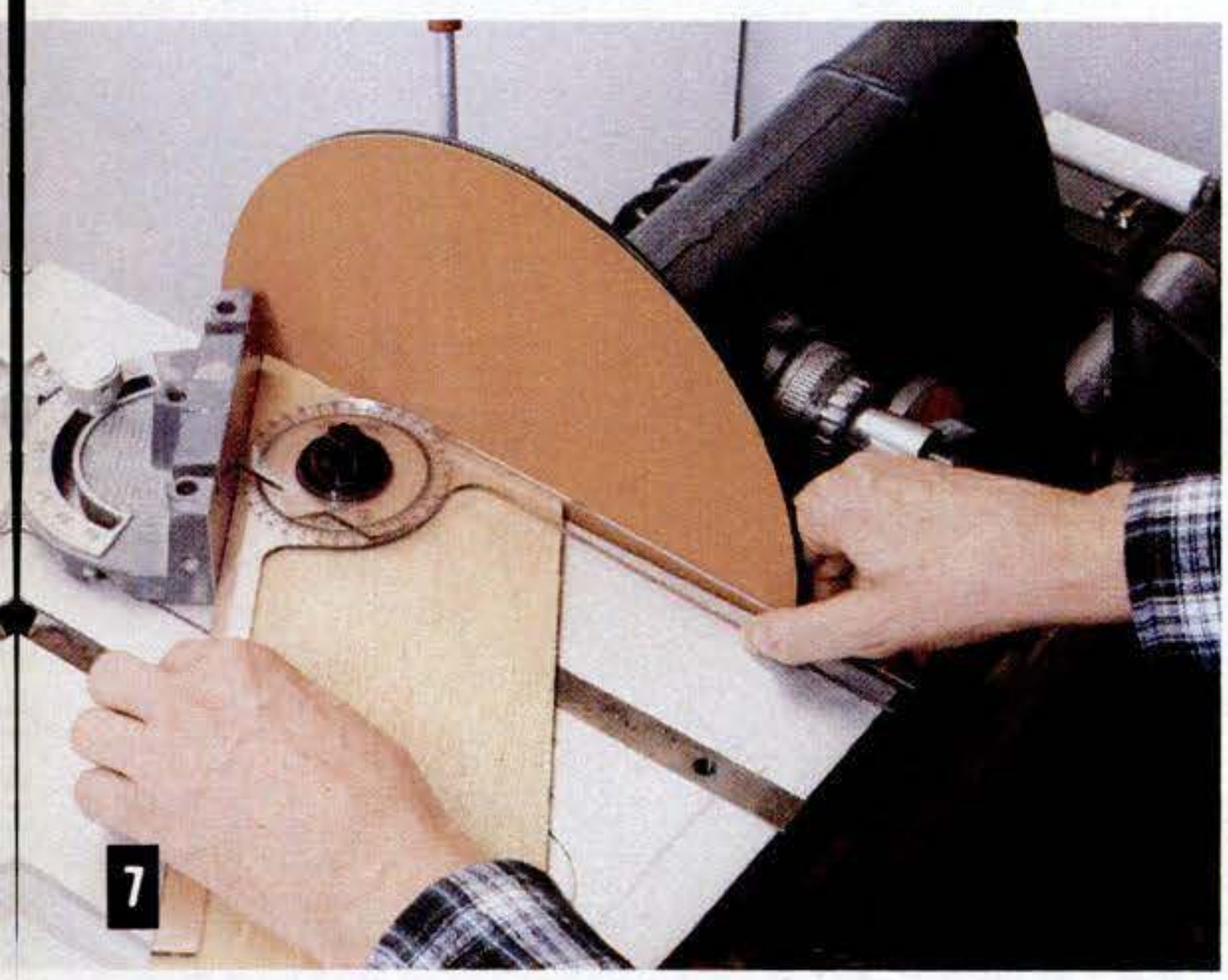
Molding scrapers (above) are far more efficient than sandpaper for removing tool marks and other flaws from moldings. The eight blades in this set will handle most shapes. Blades are sharpened like chisel blades, not burred like hand scrapers. While molding scrapers are made primarily for preparing and refinishing moldings, you will find many uses for them in your shop. The Garrett Wade set shown costs about $23.

Dremel's four-inch tilt-arbor table saw (model 580, right) is not a toy. Powerful it's not, but it is versatile, handy, and accurate. And it's so quiet I can run it late at night. If what I have to cut is not too big for the saw's 10-by-12-in. table and one-in. capacity, I will use the Dremel instead of my 10-in. table saw. It's beautiful for rabbeting (a little slow with multiple passes for dadoing). I have built a tenoning jig for it and am planning other jigs. Two blades are available: a 30-tooth combination and a 100-tooth fine blade. The saw is widely available for about $100.



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Mite-R-Gauge (above): Measuring and setting precise angles is important in many woodworking projects, and it can be difficult to accomplish. Interpolating inscribed settings on power tools can be hazardous to your accuracy. The usual method of using a sliding bevel with a protractor requires two steps and provides a fine opportunity to lose accuracy in the transferring process. Shopsmith's Mite-R-Gauge protractor/bevel ($11) solves the problem by letting you measure, lock, and read either inside or outside angles in a single step. The 10-inch arms take all the problems out of setting accurate table-saw and sander angles.

Maxi-Clamp (above right): Nobody's shop ever has enough clamps. And no matter how many clamps you have there will be some jobs you can't get hold of, and some repetitive jobs where you can go mad clamping and unclamping. Shopsmith's Maxi-Clamp will come to your rescue. If what you are trying to clamp has solid surfaces, you can, with ingenuity, put together the 70 parts of the Maxi-Clamp system—pressure feet, rods, fasteners, clamping jaws, and multi-hole junction blocks—in various combinations that will hold, push, pull, or position just about anything. For example, I recently used the system to assemble spline-mitered ogee feet for a cabinet. With the Maxi-Clamp I could hold the ends in exact position while applying pressure only to the mitered glue line. Another job was assembling 14 drawers, all the same width and depth, for a tool cabinet. With that many, you want to glue each drawer in one shot. I did, with the setup shown. The Maxi-Clamp system costs about $50. After you get one, buy additional washers, hex nuts, and ⅜-in. threaded rod—a couple of six-ft. lengths standing in the corner let you cut extra-long rods, and you can clamp almost any object that comes along. However, the Maxi-Clamp system is not a replacement for C-clamps, wood-jaw clamps, and pipe clamps.

Turn page for more wood-shop tools

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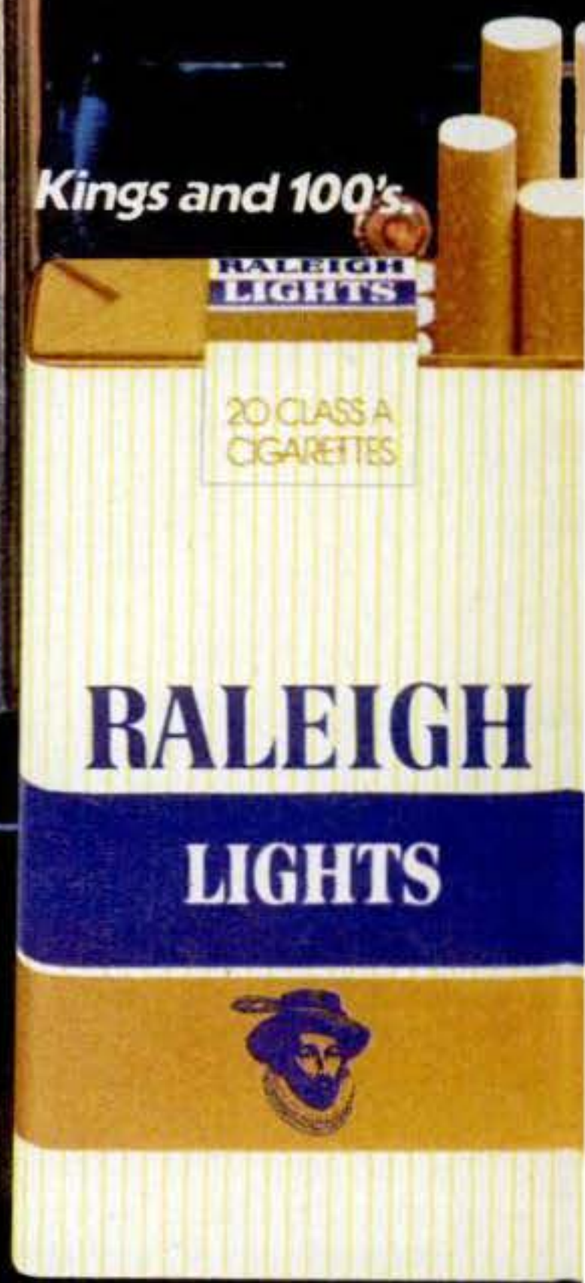
Warning: The Surgeon General Has Determined That Cigarette Smoking Is Dangerous to Your Health.

Lights Kings, 8 mg. "tar", 0 .7 mg. nicotine; Lights 100's, 9 mg. "tar", 0 .8 mg. nicotine av. per cigarette, FTC Report Dec. '81.

Take the road to flavor in a low tar cigarette.



RALEIGH LIGHTS

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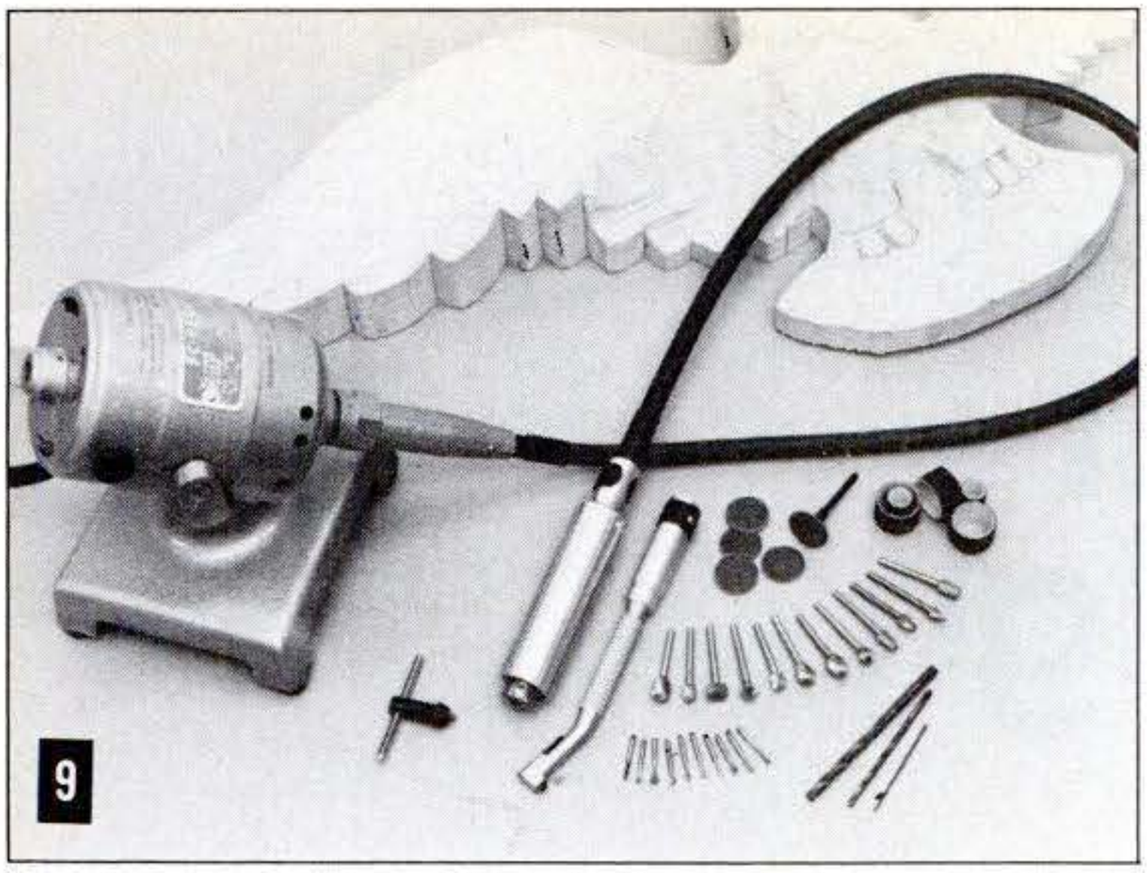
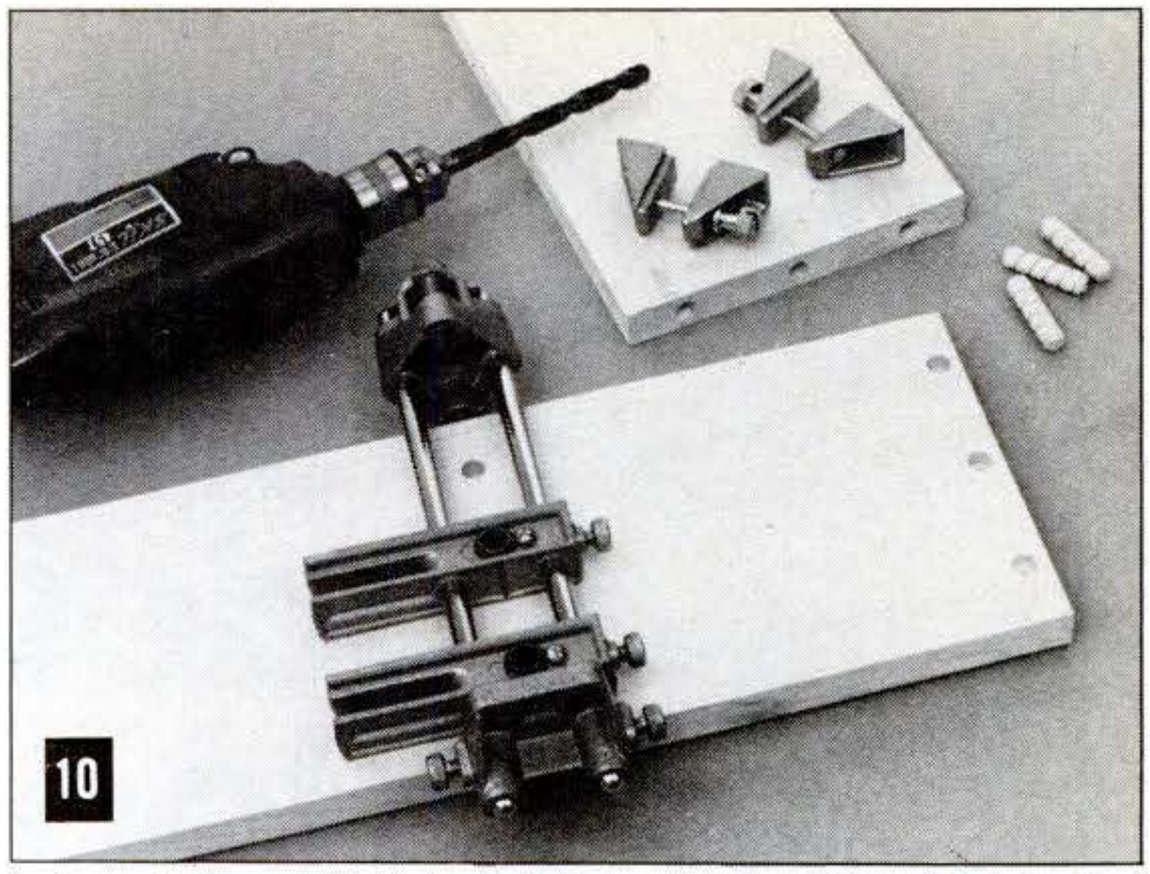
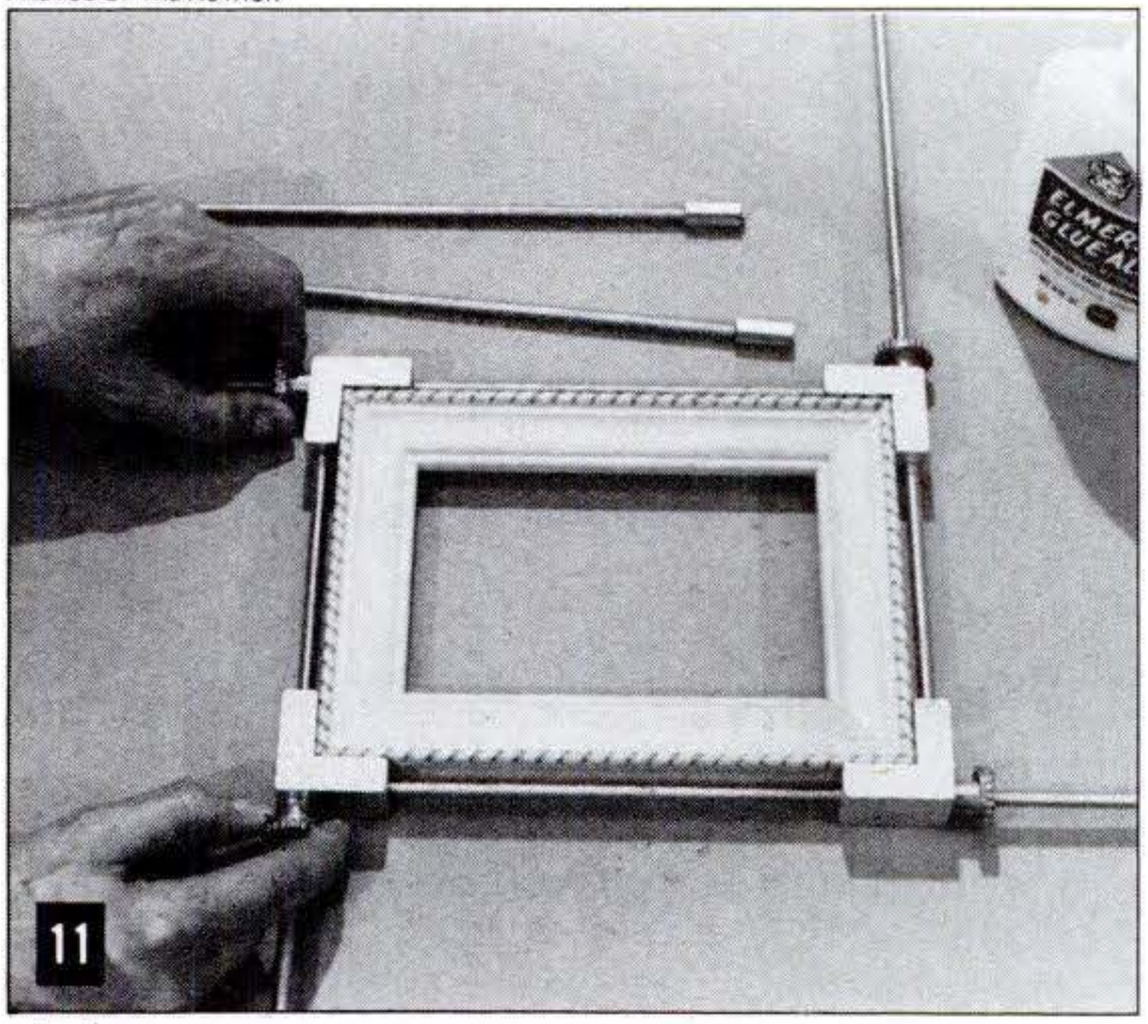


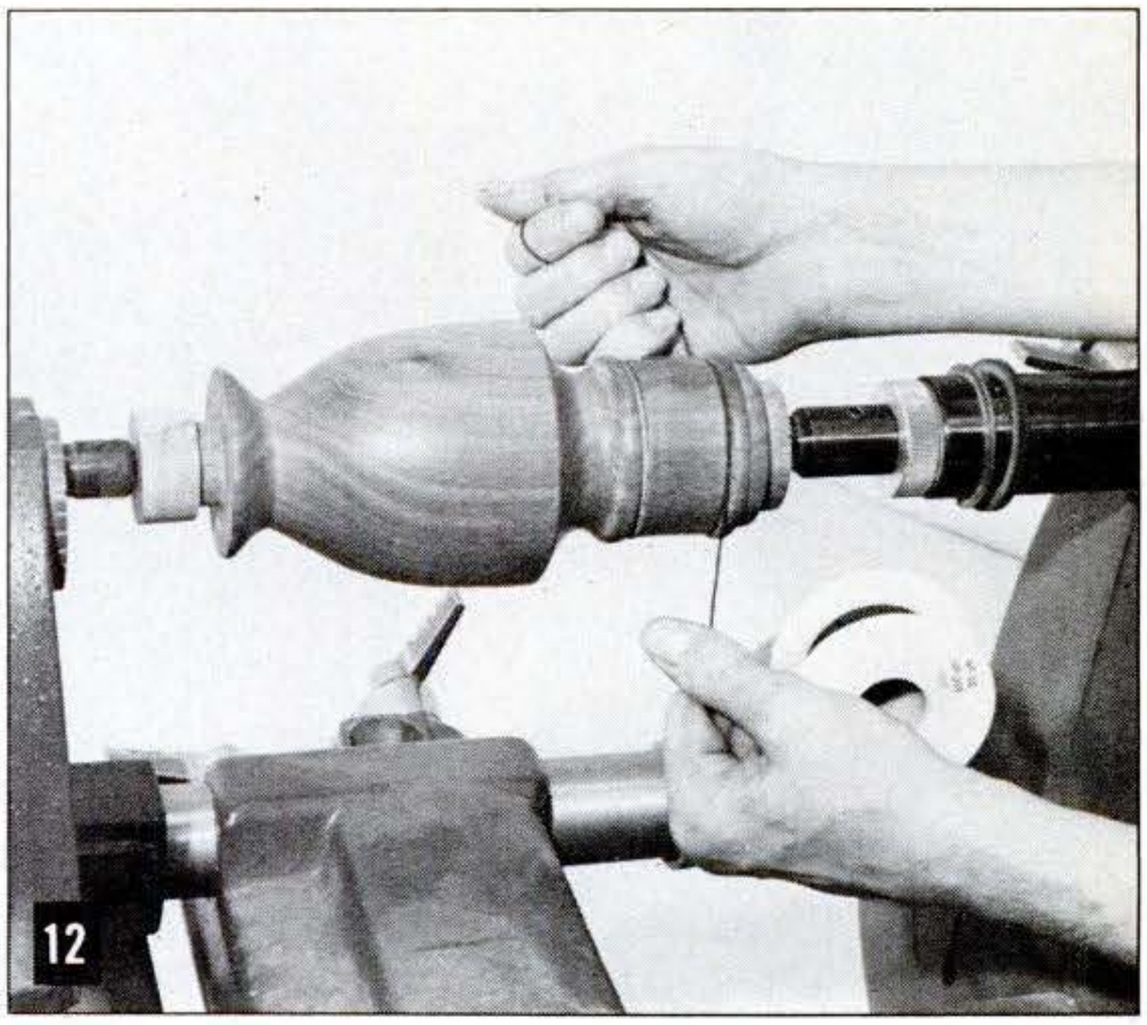


Foredom hand grinder (above): Hand grinders are useful for many operations—carving, drilling, sanding—particularly in inaccessible places. But Foredom's flexible-shaft models are the handiest of the lot. These miniature power tools are made in six motor styles with 15 interchangeable handpieces. I have the No. 30 handpiece with key-type geared chuck, which will take twist drills and burrs, etc. with shafts up to 5/32 in. I also have the No. 55 contra-angle dental-type handpiece—very handy for getting into tight places with short latch-type mandrels and burrs. Foredom tools are carried by several mail-order tool houses. Bench-style and hang-up motors with electronic foot controls run approximately $200. The No. 30 handpiece costs $30; and the No. 55, $95.

Record doweling jig (above right): Most doweling jigs are far from versatile. Several will only locate dowel holes in the edges of boards or in framing; one will center dowel holes between edges only, unless you add a shim; another locates mating holes in boards for corner joints. Although my preferred method of drilling dowel holes is with a drill press or by means of horizontal boring with a Shopsmith, there are many occasions when I have to use a doweling jig instead. The Record model 148 doweling jig ($60 from Garrett Wade, $52 from Constantine) is the one jig I have not been able to stump with a doweling problem. It is the only one I know of that will locate dowel holes in the middle of a board. It will locate any holes needed to make casework furniture and will guide the drill for perpendicular drilling. As it comes, the English-made doweling jig will locate holes anywhere on any surface of a board up to six inches wide. Additional guide rods are available to increase width capacity to 12 and 18 inches. But you could drill holes across the center of a 48-by-96-in. plywood panel by substituting 3/8-in. drill rod for the guide rods. The tool comes with 1/4-in., 3/8-in., six-mm, eight-mm, and 10-mm drill guides (5/16-in. is available).

PHOTOS BY THE AUTHOR





Miter-frame clamps (above) solve a standard woodworking problem: how to apply clamping pressure on a mitered joint for a picture frame or box. Corner clamps won't do it. They will position the parts, but they won't apply pressure. This miter-frame clamp will clamp all four corners in one shot. The aluminum-alloy corner blocks will not mar the work. Parts will be held with absolute accuracy. And if your miters are not exactly 45 deg., or if one side is 1/16 in. short, you will know it. With additional threaded rods cut to length, you can extend the clamp to hold any-size frame or box you can lay flat on your bench or the floor. Some versions of this versatile clamp use 1/4-28 threaded rod, which makes it difficult and expensive to rig such extensions. I like the version that uses common 1/4-20 threaded rod. With it, economical clamp extensions can be made with the threaded rod available at hardware stores and readily obtainable hex coupler nuts. The miter-frame clamp's usefulness is not limited to mitered joints. Any kind of box or carcass joint can be clamped. Incidentally, with this clamp and accurate mitering you can put picture frames together with glue alone. Miter-frame clamps, with 18-in. rods, are available for about $18 from Constantine, others.

Abrasive cords (above) have their biggest home-shop application in cleaning the residue of old paint and varnish out of the deep grooves in turnings after using paint stripper. I find them handy for sanding the grooves of new turnings, too, because they do the job a lot more efficiently than strips of sandpaper (which seem to tear apart just as you get them started working). The abrasive-impregnated cords come as round cords or flat tapes, in 150 and 180 grits. They are made by E.C. Mitchell Co. and sold by the maker and many other mail-order sources for $8 to $10 per 25-yd. spool. Smaller (30-ft.) sample spools are available from the manufacturer—three spools for $10.

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Popular Science ELECTRONICS

Use your computer as a solar design tool

An architect tells how he designed and tested his add-on sunspace

By JEFFREY MILSTEIN

Before driving the first nail, I knew what my add-on sunspace [PS, May] would look like and how it would perform as a heat source.

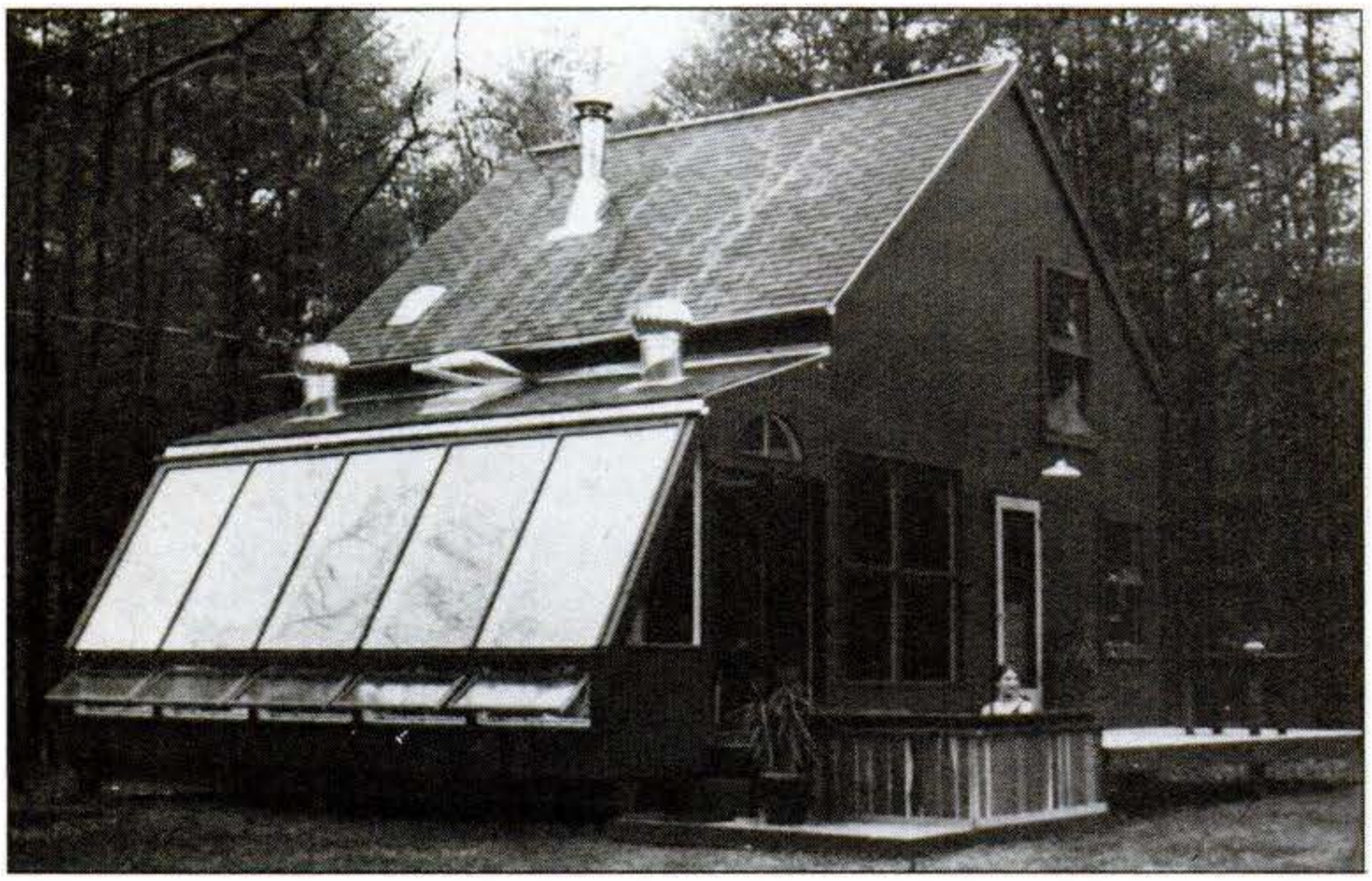
I used my Apple II Plus computer with 48K capacity to run two programs: Apple World for the three-dimensional graphics and TSWING for the solar-performance analyses. Apple World requires one disc drive; TSWING needs two.

First I sketched out the structure on graph paper to get the computer-entry points. Then, using the "editor mode" of the program, I entered the coordinates of each line into the keyboard. It's like giving someone directions: Go two blocks west, one block south, and take the elevator to the 10th floor. This is not as difficult as it might sound. The more I worked with the program the easier it became to convert lines into the x, y, z coordinates the program uses to make the 3-D drawings.

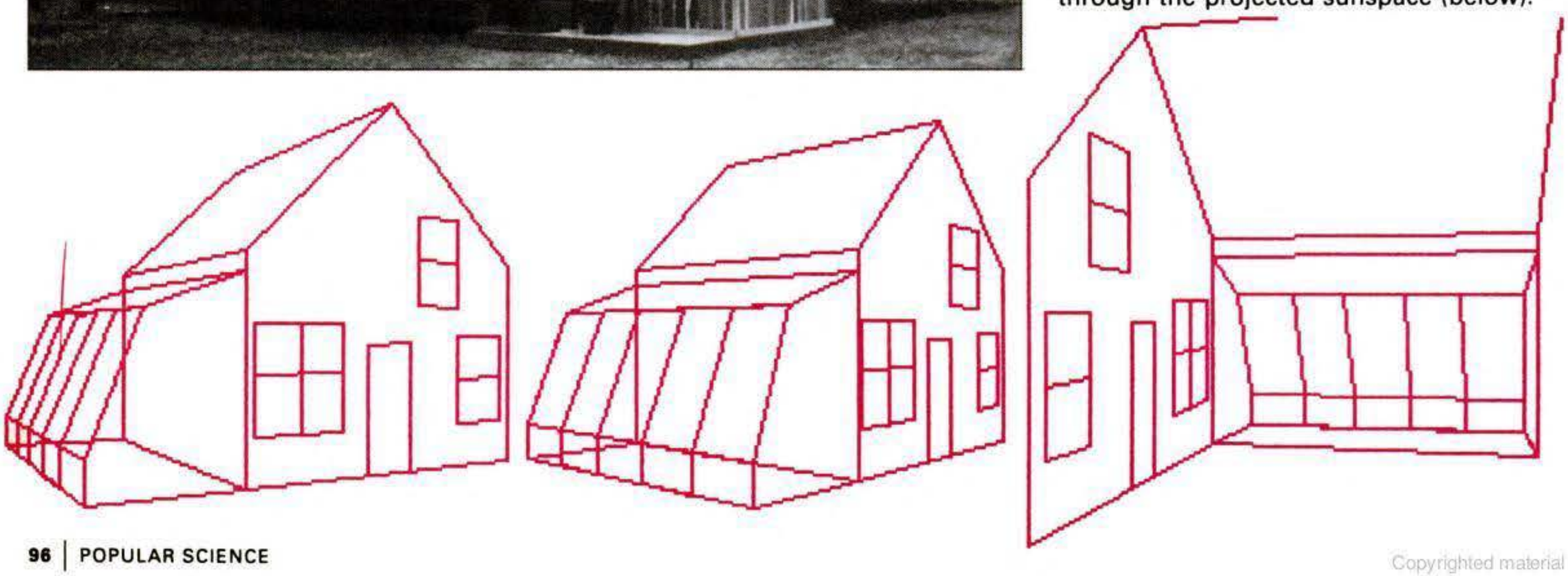
In the editor mode you can also erase or add sections easily. As you try different shapes you can save all or part of any drawing by storing it on a disc. The collection of shapes can be called up whenever you need it or turned into hard copy on a printer if you have one.

The program does not erase hidden lines—the ones that would normally disappear as the object rotates. But I got around that by entering only two sides of the structure at a time.

Continued



Apple World program drew 3-D sketches that became addition (left). Drawings could be rotated for viewing from any angle. Zooming up an axis produced a view from inside the house looking out through the projected sunspace (below).



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— Isaac Asimov
Renowned Science and Science Fiction Author

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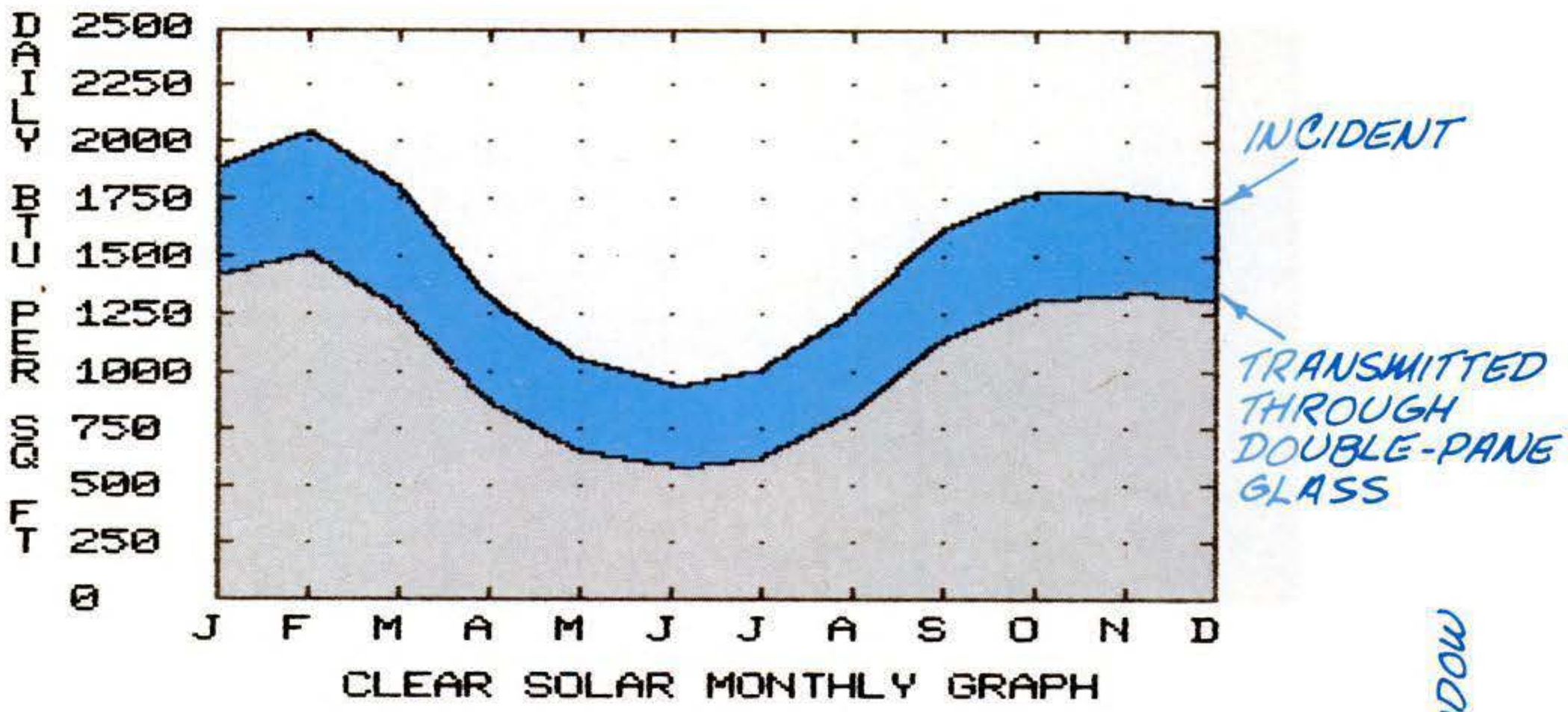
Computer-generated graphs and tables predict solar performance



CLEAR SOLAR MONTHLY GRAPH

LATITUDE: 42 AZIMUTH: 0 TILT: 90
MONTH 1

HOUR	SUN ALTITUDE	SUN AZIMUTH	SUN ANGLE OF INCIDENCE	INCIDENT BTU: DIRECT RADIATION	DIFFUSE RADIATION (SKY DOME)	REFLECTED GROUND	TOTAL SOLAR GAINS	SOLAR GAINS IF A SHADING DEVICE USED	SHADING FACTOR (% OF WINDOW SHADED)	TRANSMITTED BTU: OPTIONAL SIZE WINDOW (1 SQ. FT.)	
HR	ALT	AZM	INCID	DIR	DIF	REF	TOTAL	SHADED	S.F.	TOTAL	SHADED WINDOW
8	7	55	55	68	3	2	74	74	0	54	54 54
9	15	44	46	159	7	7	173	173	0	130	130 130
10	22	30	37	213	8	12	233	233	0	176	176 176
11	26	16	31	244	8	14	267	267	0	204	204 204
12	28	0	28	254	8	15	278	278	0	213	213 213
13	26	16	31	244	8	14	267	267	0	204	204 204
14	22	30	37	213	8	12	233	233	0	176	176 176
15	15	44	46	159	7	7	173	173	0	130	130 130
16	7	55	55	68	3	2	74	74	0	54	54 54
							---	---		---	--- ------
							1772	1772		1339	1339 1339

After drawing the east and south sides of my house and saving that on disc, I drew several different configurations of the sunspace, which I saved under different labels. Then I could call up whichever shape I wanted to look at, "attach" it to the house, and look at it from all angles. I even got an inside view by zooming up one of the axes.

Limits? The lines are not as perfect as on those big expensive jobs, but for a home computer they're pretty good. Not only does the computer serve as a valuable tool for designing, it's as much fun to play with as any home video game could be.

Once I designed the sunspace, I checked its performance by reprogramming the Apple with TSWING. This is a network-simulation program that takes your building and predicts its inside temperature swings hour by hour. It draws easy-to-read graphs that let you quickly balance the thermal mass or compare the effects of different glazing or insulation. You can even overlay graphs to get instant comparisons.

In the past, network-simulation programs have been used only by solar experts because it was time-consuming and difficult to set up the "nodal matrix" required. The nodal matrix consists of points in the thermal masses and in the air of the building where you theoretically place thermometers to measure temperatures every hour over a 24-hour period. The computer uses these temperature measurements to calculate how much heat is held and how much is transmitted by the structure between the various points.

Continued

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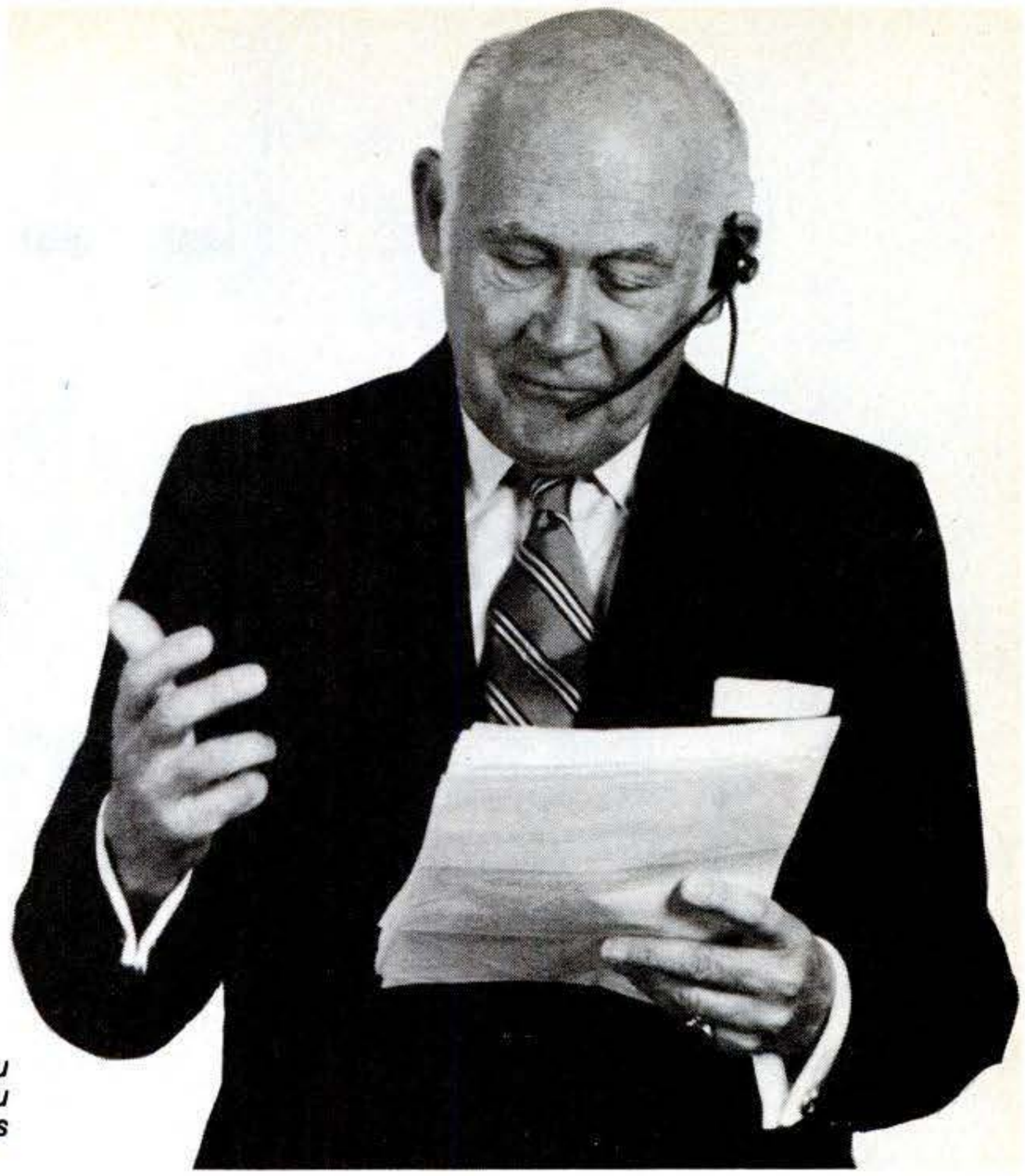
Charlie's Phone

A cordless hands-free telephone is the ultimate step in total telephone freedom. Just ask Charlie.



There's a new sense of freedom when you wear the Go Fone headset. The black box you carry measures less than an inch thick and is 2½" x 4" in size weighing only six ounces.

Charles Haven uses it. And as Chairman of the Board of his privately-held corporation, he finds it quite handy. Here's why.

The Technidyne hands-free cordless telephone (called the Go Fone) consists of a boom mike connected to an earphone. The earphone does not plug in the ear but comfortably rests on it.

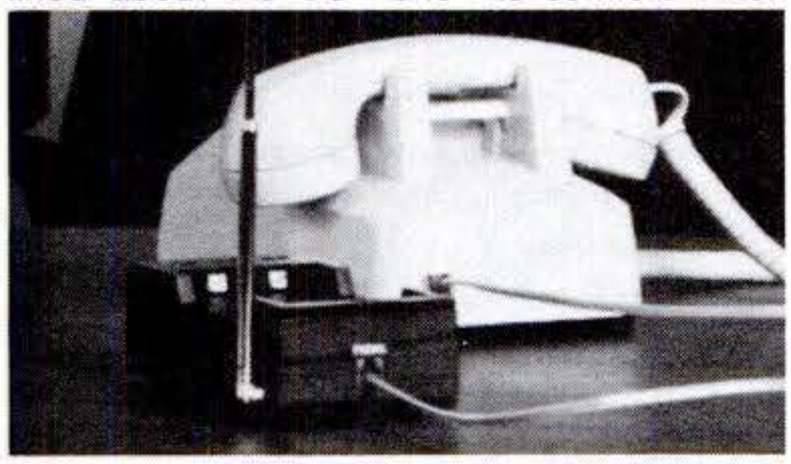
The entire unit weighs only a few ounces so you hardly know you're wearing it. A light cord connects it to a small black box that either goes in your pocket or is clipped to your belt.

THE UNIT BEEPS

When Mr. Haven hears his unit beep, he flips a switch on the black box and says, "Hello." Mr. Haven can then carry on a complete hands-free conversation. He can walk over to a file cabinet, walk into the reception room, step out on his office balcony, take notes, scan computer printouts and do all of this with both hands free and no wires to drag around. His callers will not hear anything unusual.

His wife has even more fun. She can do the dishes, put away the groceries, answer the front door, and relax while talking to somebody who is stuck holding a conventional phone.

But there's one feature that we especially liked about the Go Fone—its comfort. After talking for hours on a standard telephone, your ear and hand can feel the stress. With the Go Fone you can talk for hours without stress.



Just plug the phone line into the recharger along with your conventional phone and extend the antenna.

You carry the small black box in your pocket. At the end of the day, you place it in the recharger and it will be recharged and ready for an average day's telephone activity.

LOVE THE FREEDOM

If you're a busy executive, you'll love the freedom and comfort of the Go Fone. You don't have to keep the Go Fone on your ear either. It goes on so quickly that you simply place the unit over your ear when the phone rings and flip a switch. But we think you'll really like to keep the unit on all the time—it's that comfortable and that unobtrusive.

The entire system is quite simple. There's a base unit into which you plug your regular telephone and your telephone line using a modular plug. If you do not have modular plugs on your telephones, you can obtain them quite easily from your local telephone company. If you have a multi-line phone, your phone company can install a phone jack.

The base unit also is a recharger for the Go Fone's small black box. At the end of the day, simply replace the Go Fone portable unit into the base unit and let it recharge overnight.

WORKS EXACTLY

The range on the Go Fone is 200 to 300 feet—a range that will cover most homes and offices. Once connected, your regular phone will work exactly as it did before. But now you can answer a call a few hundred feet away with the Go Fone.

We highly recommend that you give the Go Fone a personal test during our 30-day trial period. Use it at the office and at home. See if it doesn't bring a new sense of freedom when you talk on the phone, and experience how it makes telephone usage less stressful. If you're not absolutely convinced that it's worth every penny, return your unit for a prompt and courteous refund.

Charles Haven is a pretty happy man these days. He has a nice family, owns a nice business, drives a nice car and owns a very unique cordless telephone. Why not join Mr. Haven and order a Go Fone at no obligation, today?

To order, send a check or money order to the address below or credit card holders call toll free **800 228-5000**. When ordering, please use the order number (shown in parentheses) for faster service. One year limited warranty. Please add $3.00 for postage and handling and Ill. residents add 6% sales tax.

Go Fone (1025PS01) **$149.95**

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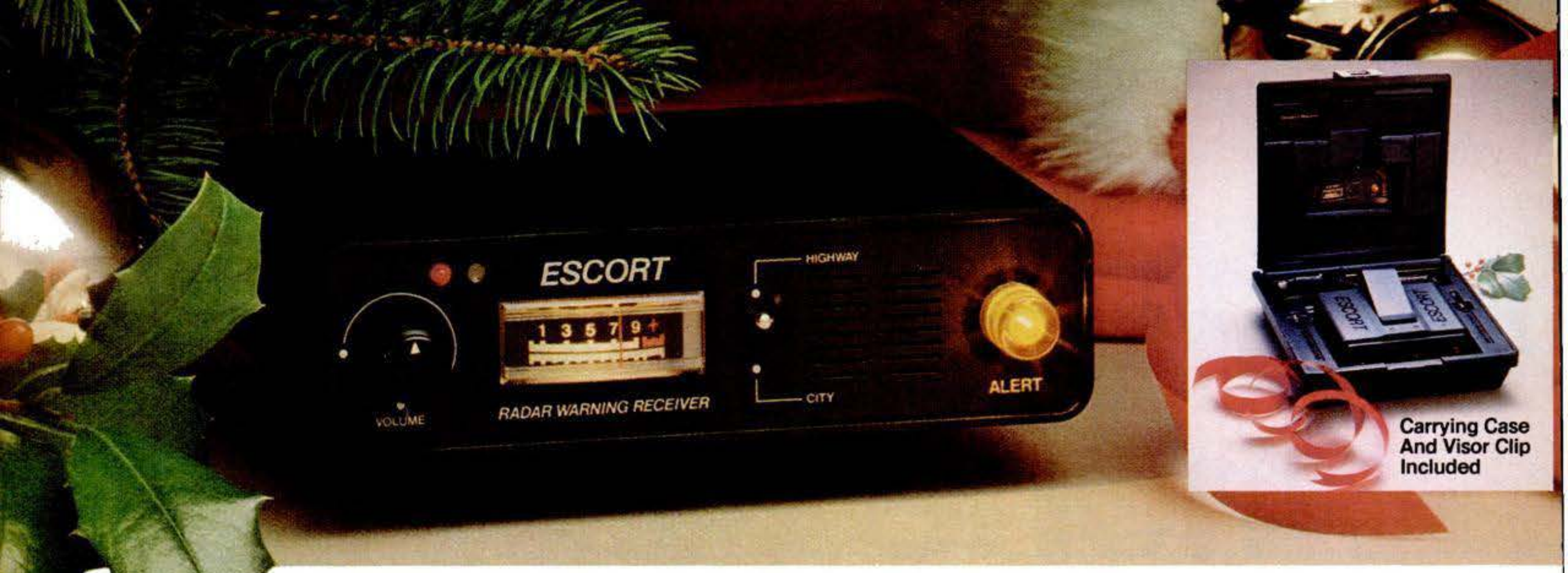

Radar Intuition

Your stereo will demonstrate this radar detector's unusual abilities.

What Could Be Better Than Unbelievable Range?

By now, you've probably heard some tall sounding stories about how far away the ESCORT® radar warning receiver picks up radar traps. You know, the ones where they talk in miles instead of car lengths. The stories go on to say that ESCORT's superheterodyne receiving circuits provide as much X and K-band warning as you can possibly use, and then some. If you've never used an ESCORT, they may seem pretty far fetched, but most of them are true. Over hills, around corners, and from behind.

Car 54 Where Are You?

Maximum detection range is wonderful, but it's far from the whole story. In some ways, radar detectors are like smoke alarms; you want to make sure that you don't miss anything, but you don't want a lot of false alarms. ESCORT won't disappoint you. Beyond that, when a smoke alarm sounds off, the most pressing thing on your mind is: Where is the fire? Is it ahead of you, behind you, above you, or below you? In the same room, or at the other end of the house? Your senses can help you find fire, but, on the highway, you can't feel or smell radar. ESCORT is your sixth sense.

Hearing Is Believing

ESCORT reports its findings straight to your ears in a way no other detector can match. Its vocabulary includes a Geiger-counter-like pulsating rhythm that relates radar intensity in a smooth, natural, and intuitive manner, making it easy to sense the distance to radar. It can tell you if radar is ahead of you, behind you, or even traveling along with you in traffic. ESCORT also speaks different languages for each radar band. Since the two bands behave differently, the distinctive tonal differences eliminate surprises. You'll even be able to tell "beam interrupter," "trigger," or "instant-on" type radars from other signals just by the sounds they make. Ditto for radar burglar alarms and door openers. ESCORT has a lot to say, and we've developed a new way for you to get acquainted quickly.

Play It, Sam

ESCORT's instruction book contains a wealth of information. Actually, it's the ESCORT user's Bible. But, the quickest way to become fluent in ESCORT's language is to play the Radar Disc on your stereo turntable. You'll hear firsthand how to interpret what ESCORT tells you in a number of situations. We now include this special Disc with every ESCORT so you can take a test drive as soon as you open the box.

No Stone Unturned

The ESCORT Radar Disc is the latest addition to a long list of standard features. We don't scrimp on anything. Here they are: ■ Patented Digital Signal Processor ■ Different Audio Alerts for X or K Band Radar ■ Varactor-Tuned Gunn Oscillator tunes out false alarms ■ Alert Lamp dims photoelectrically after dark ■ 1/64 Second Response Time covers all radar ■ City/Highway Switch filters out distractions ■ Audio Pulse Rate accurately relates radar intensity ■ Fully Adjustable Audio Volume ■ Softly Illuminated Signal Strength Meter ■ L.E.D. Power-On Indicator ■ Sturdy Extruded Aluminum Housing ■ Inconspicuous size (1.5H x 5.25W x 5D) ■ Power Cord Quick-Disconnect from back of unit ■ Convenient Visor Clip or Hook and Loop Mounting ■ Protective Molded Carrying Case ■ Handy Cigar Lighter Power Connection ■ Spare Fuse and Alert Lamp Bulb.

New!
33⅓ RPM Radar Disc

What The Critics Say

Car and Driver: . . . "Ranked according to performance, the ESCORT is first choice . . . it looks like precision equipment, has a convenient visor mount, and has the most informative warning system of any unit on the market . . . the ESCORT boasts the most careful and clever planning, the most pleasing packaging, and the most solid construction of the lot."

BMWCCA Roundel: . . . "The ESCORT is a highly sophisticated and sensitive detector that has been steadily improved over the years without changing those features that made it a success in the first place . . . In terms of what all it does, nothing else comes close."

Playboy: . . . "ESCORT radar detectors . . . (are) generally acknowledged to be the finest, most sensitive, most uncompromising effort at high technology in the field."

Autoweek: . . . "For the third straight year, no manufacturer has bettered the ESCORT's sensitivity . . . the consistent quality is remarkable."

Made In Cincinnati

If you want the best, there's only one way to get an ESCORT. Factory direct. Knowledgeable support and professional service are only a phone call or parcel delivery away. We mean business. In fact, after you open the box, play the Radar Disc, and install your ESCORT, we'll give you 30 days to test it yourself at no risk. If you're not absolutely satisfied, we'll refund your purchase as well as pay for your postage costs to return it. We also back ESCORT with a full one year limited warranty on both parts and labor. So let ESCORT change radar for you forever. Order today.

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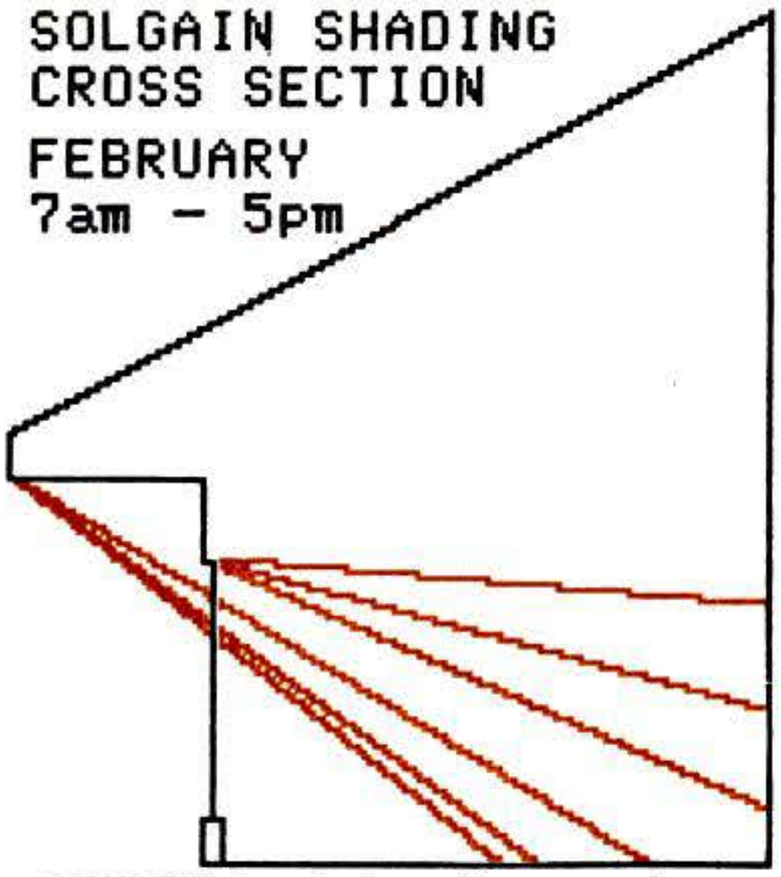
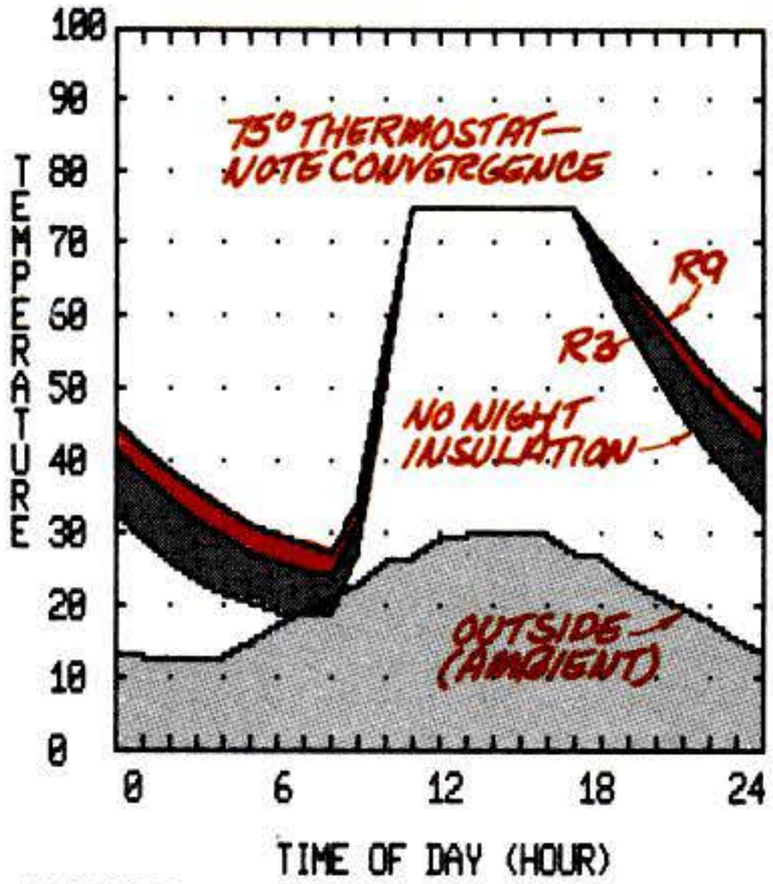
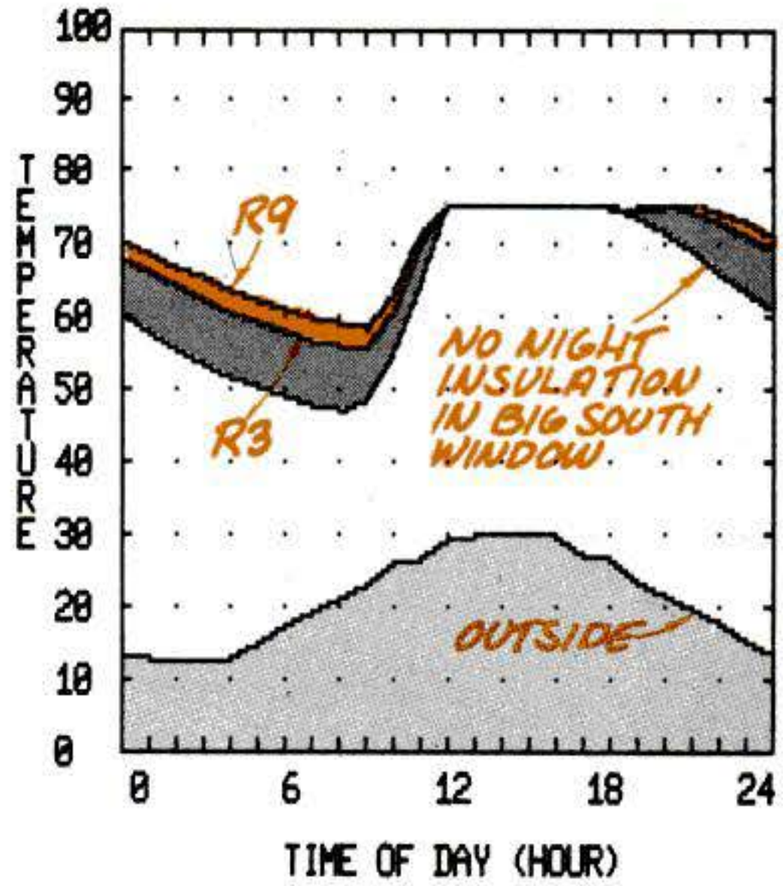


SOLGAIN sketch shows how one of several roof overhangs will affect the way sun's rays strike a room during selected days.





TSWING graphs reveal big changes in sunspace temperature without mass (left), small ones with mass (right). They also show results of night window insulation and of 75-degree-F thermostat that signals fan to move hot air into house.

To simplify and speed up this procedure, TSWING's newly updated program has an automatic setup option for many simple structures. Called the "zone-by-zone" approach, it allows you to set up the thermal network by answering a series of questions displayed on the computer screen.

When I ran comparative analyses —they're called sensitivity studies— on the sunspace, it asked me such questions as: What's the volume of air in the room? How many air changes per hour? What's the heat loss through the skin? What are the number and type of thermal mass units? How thick is the mass? What are the heat-transfer factors between nodes and the solar-gain distributions?

Much of this is explained quite well in the 75-page handbook that comes with the program, but you still must know how to do a standard building heat-loss calculation as described in the ASHRAE handbook (issued by the American Society of Heating, Refrigerating and Air Conditioning Engineers). There are built-in "default" values for many of the answers, which you can override, and they speed data entry.

TSWING also allows you to enter values for movable night insulation, internal heat gains from such things as appliances, the effects of two thermostat settings, and heat loss to objects at a constant temperature—such as the earth. The program takes all this descriptive information and sets up the nodal matrix.

But before you can start running the complex equation that results, you must set up "weather files"—the Btu of solar radiation and the outside temperatures for the days you wish to study. Another program on the TSWING disc, called SOLGAIN, helps you do that. It displays both graphically and with numbers the incident and transmitted radiation (with or without shading overhangs) for any latitude, window tilt, and orientation. And as if this isn't impressive enough, SOLGAIN will draw a section of a room showing the sun angles that result when you use a shade of your own choice—for any window orientation, any hour of the year.

Using this program, I calculated solar gains for all five glazing orientations of the sunspace: the south glazing with a 60-degree slope, the vertical south-facing vent windows, the east- and west-facing glass, and the skylight.

What my computer told me

Once everything was ready to run, I experimented by varying such things as the amount of thermal mass in the sunspace and the amount of insulation over the windows at night.

For one of these runs I used a clear January day, average temperature 21 degrees F, with snow on the ground reflecting more heat into the space, and a latitude of 42 degrees. A thermostat set at 75 degrees determined when air would be moved from sunspace to house.

As the printout for this run shows, with no thermal mass the sunspace would transfer 120,000 Btu to the house. Thus, without thermal mass you get maximum heat gain in the house, but at the expense of quite large, low-temperature swings in the sunspace.

Interestingly, the computer indicated that adding nighttime insulation to the windows under these conditions would have little effect. The readout shows a difference of only about 3,000 Btu. Still, if I wanted to keep plants in the sunspace, I would need enough thermal mass to even out the temperature swings and keep the plants from freezing at night.

To test the effect of a moderate amount of mass—such as a 2½-in.-thick masonry floor and a 100-sq.-ft., eight-in.-thick concrete-block wall—I made other runs with and without night window insulation. This time, with mass, window insulation made a much greater contribution to keeping the sunspace warm at night; it increased the amount of heat transferred to the house by reducing nighttime heat loss from the mass.

For me this amount of mass has worked well, keeping the plants from freezing, yet supplying a substantial amount of heat to our modest house on clear days. However, someone with a large or poorly insulated house—and no plants—might prefer to do without thermal mass so that all the heat would go to the house.

Another interesting point the graph made is that there is a much bigger difference between no insulation and R-3 insulation than there is between R-3 and R-9 insulation. This might help you decide whether to spend the extra money for high-R nightshades when it's easier for you to achieve R-3 with a layer of foil.

I was impressed with TSWING. It proved to be a powerful tool for serious solar designing. And it could save *you* from making some expensive mistakes when designing solar structures for your own home. PS

SOURCES OF PROGRAMS—AND PLANS

Apple World by Paul Lutus, United Software of America, 750 Third Ave., New York NY 10017, $60 (Atari version also available); TSWING and SOLGAIN by Bill Ashton and Matt Crosby, Solarsoft Inc., Box 124, Snowmass CO 81654, $395.

Plans for the PS Sunspace are still available. Send $11 to Jeffrey Milstein, Box 413, Bearsville NY 12409.

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BITS & BYTES

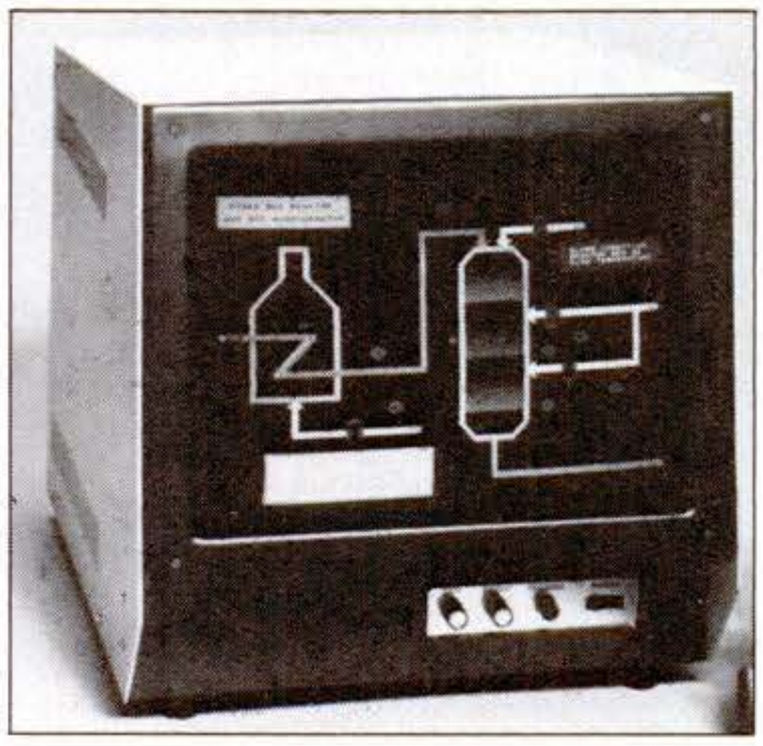
By JOHN FREE

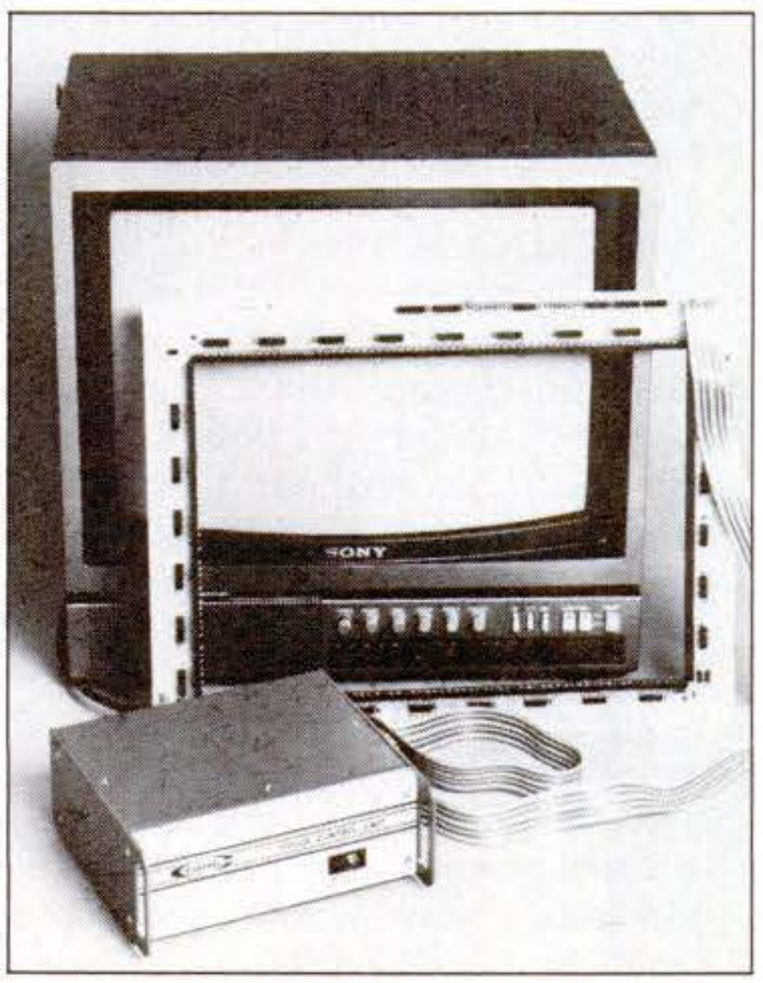
Touch-activation screens

Get used to them. CRT screens linked to computers are quickly nudging typewriters, ledger books, and push-button panels from offices, homes, and factories. In France, telephone customers are issued CRT terminals connected to a central computer instead of annual directories and the Yellow Pages.

CRT's are "windows" between an input device—often alphanumeric keyboards—and a computer. But light pens, digitizer tablets ["Computer Graphics," PS, June], joy sticks, or even speech ["Machines that Talk . . . and Listen," PS, Aug. '80] let you interact with computers, too. For its Star computer work station, Xerox has a "mouse." This candy-bar-size gadget positions an electronic screen cursor when you roll the mouse about on a desktop.

Tapping a CRT screen with your finger—touch activation—seems like the simplest interaction of all. A sensor tells the computer where you've poked the screen. And a program in its memory tells the computer what to do. Touching sections of an industrial-flow diagram (left at top), for example, might display pressure readings—or operate valves at a plant.





Screen sensors include transparent conductive membranes or a costlier technique of reading deflected ultrasonic waves. A simpler method puts an invisible grid of infrared-light beams across the screen. In Carrol Touch Technology's (Champaign, Ill.) add-on system (left at bottom), light-emitting diodes are mounted on the side and bottom of a frame. Opposite each diode is a phototransistor detector. Some 1,000 touch points fit a 12-inch display; over 3,000 cover a 19-inch one.

Touch-input technology has been used with costly mini- and mainframe computers for years. I tried a remarkable "surrogate travel" setup at MIT [PS, Aug. '81]: By touching computer-graphics symbols and videodisc images of Aspen, Colo., on a TV screen, I told the computer I wanted to "drive" through the town. What's intriguing is that setups such as this and other creative applications are now feasible on microcomputers—even budget models. Hardware costs are comparable with many personal-computer accessories.

Books and software

- Need programs or hardware accessories for your low-cost Sinclair ZX80, 81, or Timex Sinclair 1000 microcomputer? J. Randolph Hecht's *The Sinclair Computer Family Sourcebook* (Atlantic Computer Products, 5 Main Plaza, Norfolk, Va. 23510, $6.95 in softcover) provides 85 pages of software, publications, and hardware, such as 56K (kilobyte) memory add-ons or a light pen.
- Joan E. Scott's *Introduction to Interactive Computer Graphics* (John Wiley & Sons, 1 Wiley Dr., Somerset, N.J. 08873, $25.95 hardcover, $15.50 softcover) offers an overview of graphics hardware and software without becoming too technical. One chapter covers management considerations for selecting systems, and an appendix lists publications, conventions, and courses.
- Peter A. McWilliams' *The Word Processing Book* (Prelude Press, Box 69773, Los Angeles, Calif. 90069, $10 softcover) has a chapter that briefly evaluates 13 personal computers, software, and three printers for word processing. The book, sprinkled with Victorian-era engravings and editorial asides, is a quick introduction to the field.

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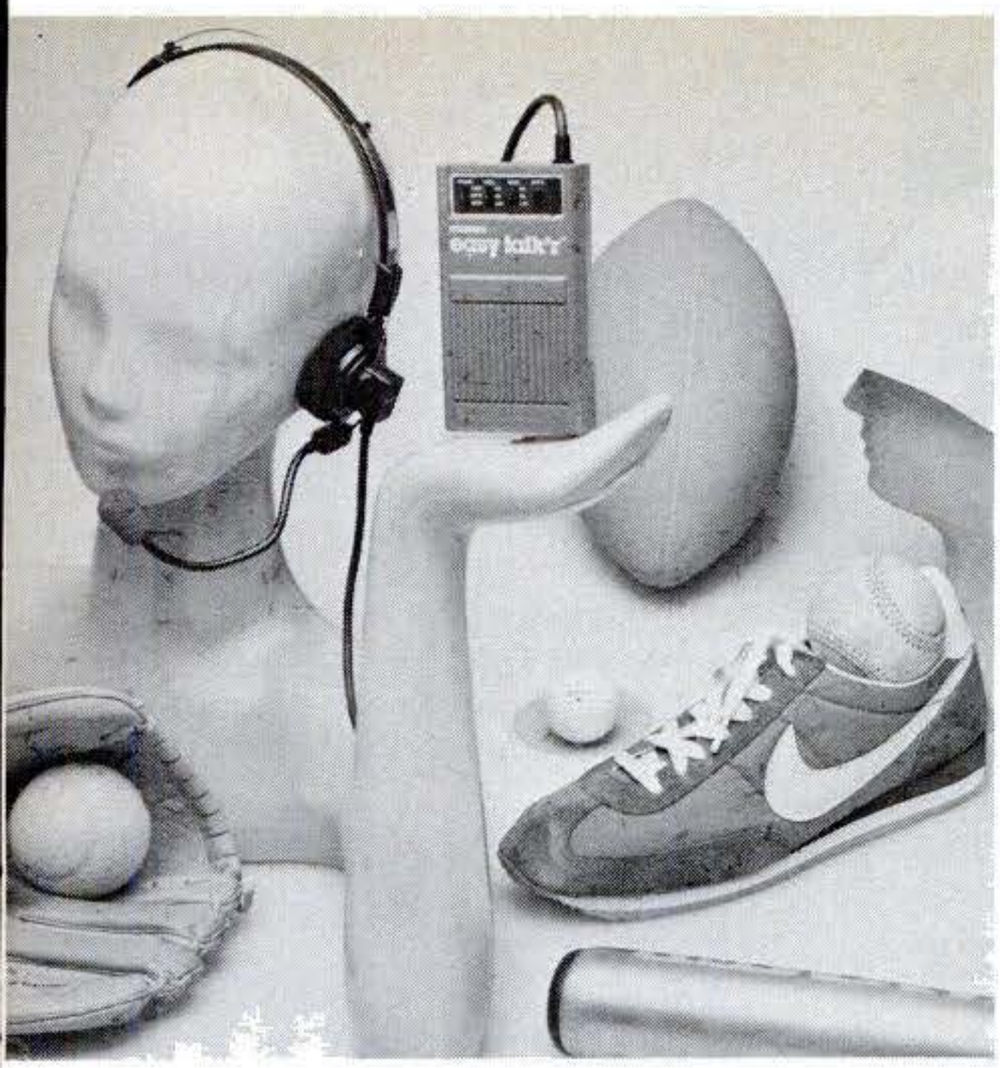

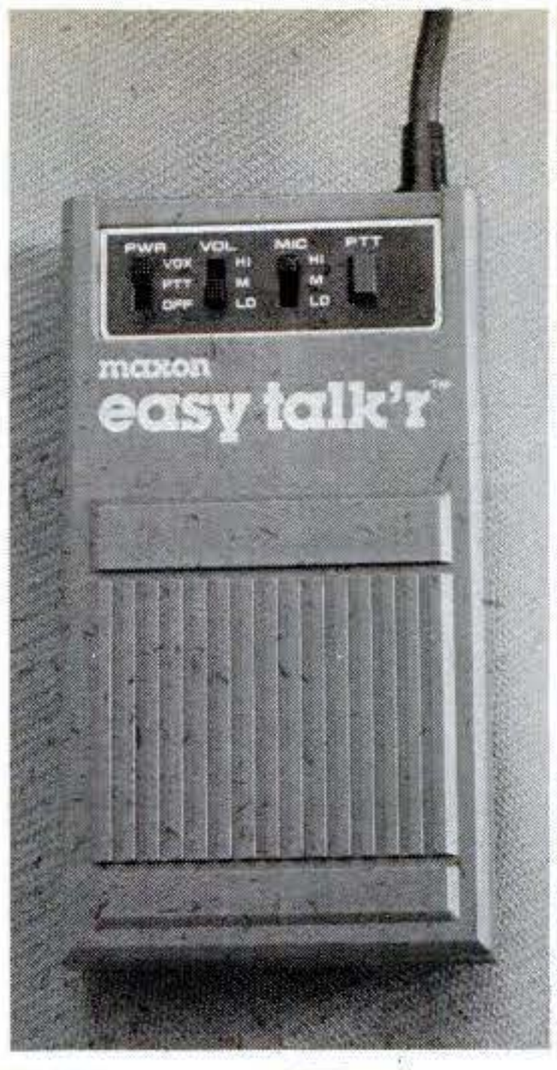

Think Speak

On the job, on the field, or on the road. Now you can talk and listen hands free at a new breakthrough price.

SWAT teams use them. So do quarterbacks and firemen. Now you too can talk and listen to people near and far totally hands free while you are jogging, riding a bike, or hiking.

Both at work and at home this unique communications system with a range up to 1/2 mile will let you keep in touch.

You'll keep in close contact with your hunting partners when you hunt, and you'll communicate for ease and safety on construction sites.

Plus, you can effortlessly perform tasks like fine tuning your TV antenna when you need to communicate with someone on the ground or out of sight.

NOT A WALKIE TALKIE

This is no toy. The Think Speak is totally automated. When you speak, a special voice activated circuit (VOX) automatically engages the transmitter so you are broadcasting. When you stop speaking, it automatically returns to 'stand by' to await a reply.

It is virtually noise free because it uses a quartz crystal locked dual conversion superheterodyne communication circuit that operates on an FM band.

So, your communication won't sound like a CB or an AM radio. You'll speak and hear with the full power and clarity you'd expect from an FM radio station.

HERE'S WHAT IT IS

You wear the Think Speak just like a personal stereo. There is an adjustable headphone that you wear on either your right or left ear. The other ear is clear to hear the outside world for safety.

A flexible boom microphone lets you speak normally while you transmit. The entire shaft of the boom mike is adjustable and will retain any position you set.

All of the electronics are contained in a small 6½ oz. case that easily clips to your belt or with its removable clip fits into your pocket. And, what controls.

The voice activation circuit has a 3 level sensitivity switch. If you're riding a motorcycle or breathing hard while you jog, you can set the sensitivity to low so that you won't transmit in error.

If you are hunting or fishing and you can't talk much over a whisper, you can set the sensitivity to high. Plus the headphone has a 3 level volume control too.

In addition to the VOX voice operated circuit, you have 'PTT' which means Push to Talk. When you want to talk, you just push the PTT button.

This is a really great feature when you want to whisper very quietly below the threshold of even the high sensitivity setting of the Voice Operated Circuit. You may be into surveillance or photographing wildlife. When you can only whisper, you'll especially appreciate the super quiet FM reception of this system.

SOME SPECIFICS

You can expect long battery life from a standard 9V battery (not included). In the 'stand by' mode, the Think Speak only consumes 13.5 milliamps of power while it's ready to transmit or receive.

The antenna is conveniently clipped to the headband for normal use. For full range use, the antenna pops up.

The system operates on the 49 mhz band using FM so you shouldn't be bothered by any other radio transmissions as you are with CBs and Walkie Talkies.

There are 5 channels (A-E) allotted to the Think Speak to further prevent interference. We will ship all units ordered on each order with the same channel.

The transmisssion output is a full RF of 10,000uV/m @ 3 meters max. No FCC license is required. And, the FM hum and noise is almost good enough for a high fidelity system at 40db min. The case is 4-9/16" x 2¼" x 15/16".

PERSONAL OR GROUP

You can talk to 1 or even 10 people with Think Speaks. So, if you're the head of a Search and Rescue team you can talk to everyone at once and get responses from one at a time.

The Think Speak is great if you're skiing with a friend, using two boats on a lake or at sea, hiking in the mountains or just jogging around the block.

If you're a pitcher you can talk to your catcher or the coach. If you're on a loading dock, you can talk to the man in the truck or on the forklift. If you're a security guard, you'll never be alone.

The Think Speak is manufactured and backed by a limited warranty from Maxcon Electronics, the two way specialists.

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Walk around the block. Take a bike ride and really test the range of this breakthrough in personal communication. If you aren't 100% satisfied with the incredible sound quality or the range, return it in its original box within 30 days for a courteous refund.

To order your Think Speak risk free with your credit card, call the DAK toll free hotline or send your check for the incredible breakthrough price of only **$49.95** each (minimum of 2 required). Plus **$2.50** each for postage and handling. Order Number 9415. CA res. please add 6% sales tax.

When you think out loud, people will listen. Try a Think Speak risk free today.

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Now you can unobtrusively snap a photo while appearing to light a cigarette. Because this refillable butane lighter is also a remarkably complex—but compact precision camera called Minimax.

Now you'll always be ready for that once in a lifetime shot, because Minimax is so light and easy to carry. Measures 4 × 1 × ⅝". Weighs 3 ozs.

Minimax's amazingly sharp negatives produce big, beautiful 3 × 5" color or B&W prints. Uses standard Minox® film cartridges in ASA speeds of 125 to 400 (available at any camera store). And there's no focusing; nothing to set. Just point and shoot.

Brown tortoise shell enamel-like finish and gold trim are durable anodized aluminum. Comes with leather-like case and year warranty. Far less expensive than similar size cameras, yet Minimax has all the quality the Japanese have brought to the art of miniaturized photography. Enjoy it risk-free for 30 days with a prompt and courteous refund if not satisfied.

ORDER TOLL FREE.

For fastest delivery, credit card holders may call our toll free lines. Order #DN839 for the Minimax Camera/Lighter. Or send a check for $95 plus 3.50 delivery. CA residents only add 6% sales tax.

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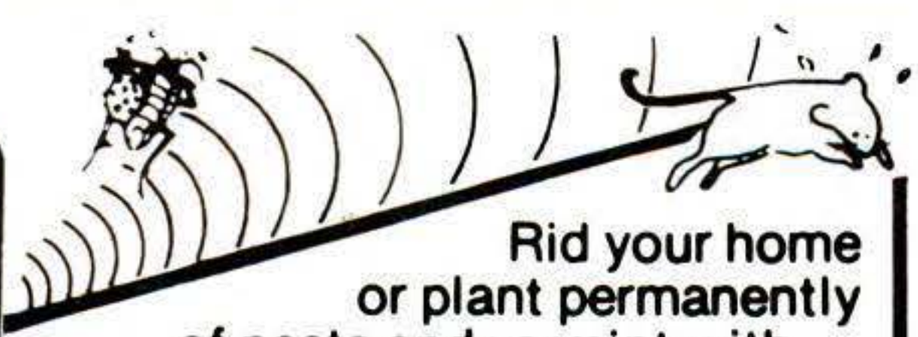

Rid your home or plant permanently of pests and varmint with ...

DECIMATE

just $69.95

It's not a pretty topic, but let's face it: mice, rats, roaches, bats, fleas, spiders, and other pests and varmint make life miserable at home or at the plant. Sure, there are all kinds of poisons that get rid of them - temporarily. Trouble is that those poisons usually contain carcinogens that endanger you and your household pets. And, unfortunately, in just a few generations (and that can take as little as a few months) the "little visitors" usually develop immunity against them.

DeciMate works on an entirely different principle - it delivers a tremendous blast of ultrasound that is totally inaudible to humans and pets, but that sounds like an onrushing 747 jet plane to pests and varmint. It totally disrupts their eating, sleeping, and reproductive patterns. They become so thoroughly discombobulated that they'll leave your home within a few short weeks - never to return. There is nothing to prepare, nothing to set up, no poison, no dead animals and never any mess. Pests just disappear. It covers about 2,000 ft.^{2} or 15,000 ft.^{3}

Just plug *DeciMate* into your 110V and watch your space become totally varmint free. You have two levels of output intensity, depending on the severity of the problem. It is a humane, clean, and totally effective system to rid yourself of pests once and for all. Clean up your home or plant and order today!

***Important Notice:** Please do not confuse DeciMate with similar looking units of low intensity and only one output level. DeciMate "sweeps" from 25,000 to 40,000 Hz. in each cycle - other units have constant frequency. They may cost a few dollars less, but they cannot possibly do the job.*

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Please give order # 104487 and your major chargecard number and exp. date. If you prefer, mail check or chargecard authorization for $69.95 plus $2 for post./insur. (plus sales tax for California delivery). You have 2-week return privilege and 1-year guarantee. For quantity orders please call or write "Premium Manager".

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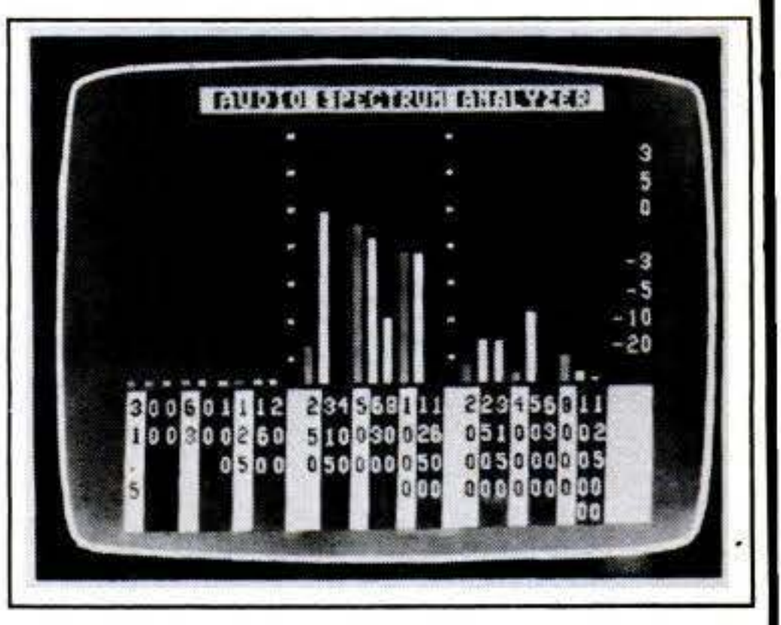
Bits & bytes

[Continued]

● Is your hi-fi system overemphasizing or de-emphasizing certain audio frequencies? The Audio Spectrum Analyzer, a $19.95 program from Radio Shack (Fort Worth, Tex.) for its TRS-80 color computer, can show you. Color bars (photo) display frequency response over nine octaves in one-third-octave segments. Eventide Clockworks, Inc. (New York, N.Y.), markets plug-in spectrum-analyzer boards and software for Apple, Commodore, and Radio Shack computers. This hardware covers the audio spectrum



from 20 to 20,000 Hz (compared with 32 to 12,500 Hz for the TRS-80 color computer software). Eventide's complete Apple package is $744.

● Mark Finkelstein and George McCarty's *Calculate Basic Statistics* (EduCalc Publications, Box 974, Laguna Beach, Calif. 92652, $14.95 softcover) covers statistics fundamentals for calculators and personal computers (one BASIC program, for multiple regression, is included). The book has excellent diagrams and clear explanations. Walter W. Hudson's *A Statistical Package for the Pocket Calculator: The SPPC Manual* (Walmyr Publishing Co., Box 3554, Leon Station, Tallahassee, Fla. 32303, $14.95, softcover) offers statistics algorithms for TI-55 or similar calculators and computers.

● All-in-one software packages—database management, calculation, communications, and word processing—are starting to appear. The Silicon Office is a new $999 package with these features from England's Bristol Software Factory, distributed by Computer Marketing Services, Inc., 300 W. Marlton Pike, Cherry Hill, N.J. 08002. It's tailored for the Commodore CBM 8032 computer with 64K RAM (random access memory) and a CBM 8050 dual-disc drive.

● Howard Franklin's *Golden Delicious Games for the Apple Computer* (John Wiley & Sons, $12.95 softcover) comes with a tear-out card for ordering a $34.95 disc that carries programs described in the book. Routines cover musical notes and sound effects, low- and high-resolution graphics, data entry, and more. The book stresses ways to write games in BASIC.

Quick looks

● Flip-top microcomputer work stations—models with CRT's that can be positioned either horizontally or vertically—

Continued

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The 79 Cent FM Problem

Don't blame your FM tuner if the stations you try to tune in are hissy and have sound that seems to break up.

Radio signals move fast. They travel at 186,000 miles per second. The same as the speed of light.

Just like light, radio signals travel only in straight lines. But unlike light, they are reflected and distorted by buildings, hills and even passing airplanes.

So, your FM tuner is engulfed in a veritable echo chamber of reflected and distorted radio signals.

The fact is, your FM tuner can't tell a distorted signal from the real thing. Nor can it stop a distorted reflection from mixing in with the original.

That's why many of the FM stations that you try to tune in are hissy and the sound appears to break up.

FREE HELP

You can solve part of the problem for free. Check the piece of wire, worth just about 79 cents, called a dipole antenna that came with the receiver. Is it simply junked behind your receiver or is it nicely spread out like a big 'T' on the wall.

If your dipole wasn't already stretched out you'll immediately notice a significant improvement in both the background noise level and distortion in your music. In fact, the improvement on many stations will be enough to make you very glad you read this ad.

So much for the free help. Your dipole is directional. It is most sensitive to FM broadcasts that are coming at it directly through the wall it's mounted on.

If you are receiving some stations now that you only hear with so so quality, you are probably picking up the distorted signals that are being reflected at you from distant buildings rather than the direct beam of the radio station.

It's a pretty good bet that you can dramatically improve the bad stations by repositioning your antenna at a different angle so that it is aimed at the station you want to receive. You'll improve the sound for 2 reasons. 1) You'll be aimed at the real signal. 2) Your antenna will reject the reflected signals coming at it from different directions.

The problem is that once you re-aim your antenna to pick up a station that was weak, the stations that were strong will now most likely be weak.

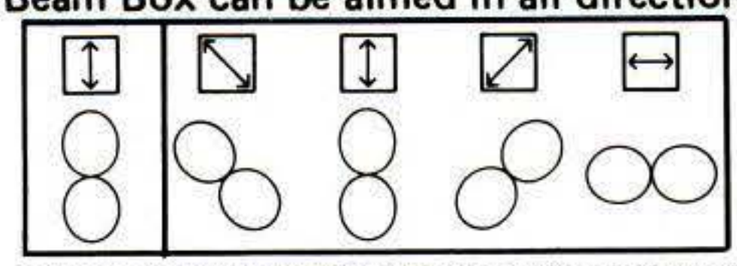
Here's the story of a new component that doesn't look in the slightest like an antenna, but will let you electronically aim your antenna where the signal is best, snuff out distorted reflected signals, and add up to 16 times the selectivity to the particular station that you want to tune in.

THE LAST COMPONENT

B.I.C. has invented (and patented) an FM antenna so revolutionary that it looks like a new HiFi component.

It's called the Beam Box. It actually contains 4 separate antenna elements.

You electronically aim the elements as you switch a directional control switch on the front panel. Unlike the dipole antenna which picks up signals from only 2 directions (front and back), the Beam Box can be aimed in all directions.



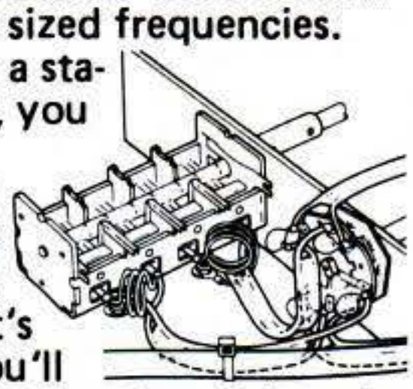
The dipole antenna at left pulls in signals only from the front and back. The Beam Box covers all points of the compass while it snuffs out distorted reflections from other directions. Something your tuner can't do alone.

You can easily tell when you've aimed properly as your signal strength meter will rise. Plus, you'll hear the sound quality go up and distortion go down.

You'll get a brighter, cleaner signal and thus your receiver can produce a brighter cleaner sound. When you're making cassette copies from FM broadcasts, you'll really appreciate the clean sound.

A TUNER IN FRONT OF YOUR TUNER

FM radio waves vary in size from 9 feet to 11.1 feet in length, depending on their frequency. Other antennas have to make a compromise as to their sensitivity to the different sized frequencies.



Once you tune in a station on your tuner, you can dramatically improve the sound by switching in the Beam Box's 4 gang tuning capacitor. It's just like the one you'll find in most FM tuners. It matches the antenna to the exact frequency of the station you select.

$5 Amplifier Bonus

DAK has made an incredible purchase on just 5800 of the high-gain low-noise Beam Booster Amplifiers. They are solid state, impedance matched and complete with a low voltage AC power supply.

You'll get a phenomenal 15db boost in FM stereo signal strength. Their list price was $24.95, and dealer cost was $16.65 just last May, but you can get one with each Beam Box you buy for just **$5** plus $1.50 for postage and handling. Bonus Order Number 9350.

Now you can pick up clear clean FM stereo even in fringe areas without hiss, distortion or drift. An ultimate solution. **Note:** Only the first 5800 Beam Box buyers from this ad can get the Booster.

The Beam Box is 12-7/8" wide, and comes with connecting cable and B.I.C. limited warranty.

TRY THE BEAM BOX RISK FREE

Connect this antenna component to your tuner. Tune in several FM stereo stations. You'll notice the improvement in signal to noise, clarity and stereo channel separation on each station.

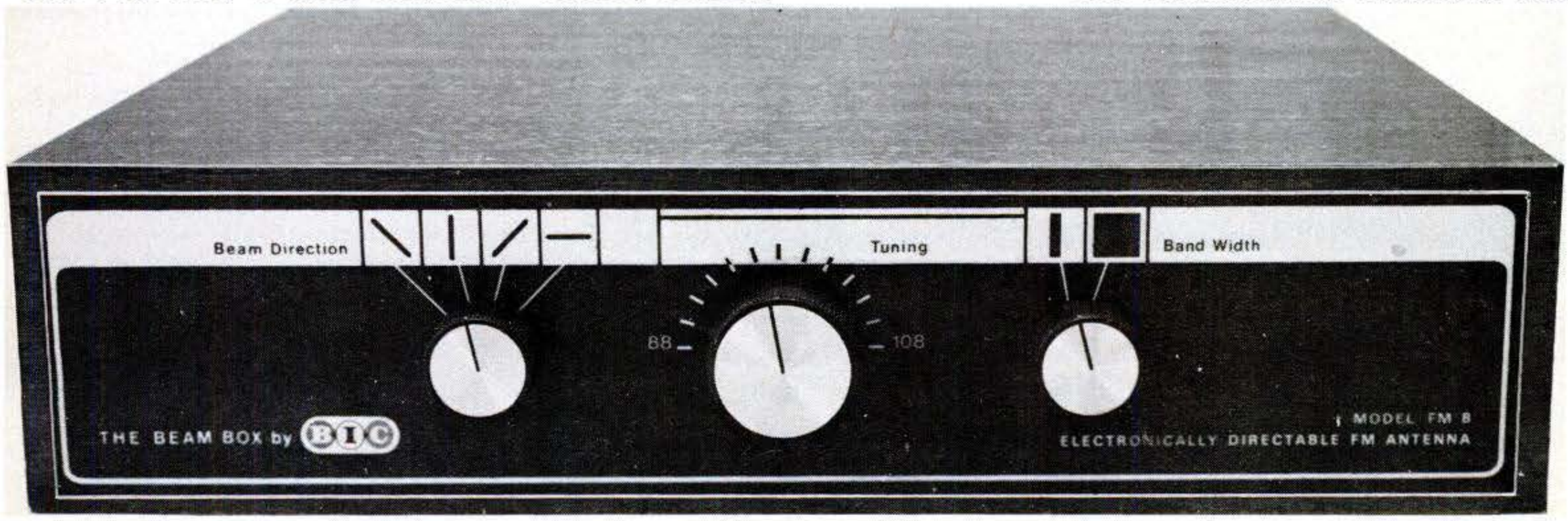
If for any reason you aren't 100% satisfied, simply return the Beam Box within 30 days in its original box to DAK for a courteous refund.

To order the patented Beam Box FM-8 risk free with your credit card, call the DAK toll free hotline, or send your check not for the regular $59 price, but for only **$39** plus $3.50 for postage and handling to DAK. Order No. 9301.(CA res add 6% tax).

With the Beam Box, you'll get more FM stations, and you'll get them better.

DAK INDUSTRIES INCORPORATED

Call TOLL-FREE ..... (800) 423-2636
In California Call ..... (213) 984-1559
10845 Vanowen St., North Hollywood, CA 91605



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SOUNDS THAT SOOTHE.

The Marsona sound conditioner generates the primal sounds of nature—the surf, the rain, the rhythmic gushes of a waterfall. And these sounds aren't recorded— but synthesized— with the use of advanced solid state electronics.

Hospitals use sound conditioners like the Marsona to relax patients in the coronary and respiratory care sections. Controlled laboratory tests at a university sleep lab indicated that sound conditioned sleepers got to sleep quicker, slept longer and received about 50% more Delta (stage 4) deep sleep.

Marsona's all-electronic design offers several advantages over earlier electromechanical models: more types of sounds (2 surf, rainfall, waterfall). There are no moving parts, no tapes, nothing to wear out. And it uses less electricity than a small night light.

And you can fine tune sounds to exactly your likes; from a mere whisper all the way up to a strong masking sound. With the surf you can even vary the rhythm from slow to fast to random.

The Marsona 1200 uses 'white noise'—long recognized by scientists for its ability to mask out unwanted noise that interferes with sleep, relaxation or work. We offer you the Marsona 1200 for a full two week money-back trial. One year warranty.

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Order product #MC643. Credit card holders may use our toll-free number. Or send check for $129 plus $4.50 delivery (in California, add $7.74 sales tax). Please mention this magazine.

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In Alaska and Hawaii 800 227-3826

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Imagine . . . the highest quality, most popular selling, micro-wave receiver system in the country . **All for only $165.00.**

Receive 24 hour a day movies, specials, sporting events, and more, all on your present television set. Install this high-powered parabolic dish system in just minutes, then sit back, relax and enjoy great 24 hour, commercial-free programming. The HMR-20 microwave receiver system is designed to be installed within sixty miles of the microwave transmission station in your area (unobstructed line-of-sight), and comes complete with all hardware: 60 feet of coaxial cable, cable adapters, power supply tuner, and installation instructions . . . All for only $165.00, including shipping and handling. We also offer our newest and most powerful antenna, the HMR-28 . . . with 40% more power for the sharpest picture possible and the longest signal distance . . . only $220.00 including shipping and handling. Both of these great antennas are tuneable through 44 frequencies, providing you the greatest selection of programming. Both units carry a 6-month limited warranty on defects in material or workmanship*. So don't wait another minute, call us right now, our lines are open 24 hours, our operators are ready to take your order.

SPECIFICATIONS HMR-
GAIN- 45db
FREQUENCY- 2.1 - 2.6GHz
DISH SIZE- 20" full parabolic
TUNING- 55 thru 75 Mhz
REGULAR SUGGESTED RETAIL- $ 325

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We gladly accept VISA or Mastercard or money order (allow 2 wks). If you prefer, your personal check (allow 4 to 6 wks).

*All units returned for refund that are not defective are subject to a 15% restocking charge.

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QTY.	UNIT	DESCRIPTION	COST	TOTAL
	HMR - 20	COMPLETE UNIT	$ 165	
	HMR - 28	COMPLETE UNIT	$ 220	
C	California Residents Add 6% Sales Tax			

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ACCT. NO. _____ EXP. DATE _____
SIGNATURE _____

Bits & bytes

[*Continued*]

are now being made by Corvus Systems (San Jose, Calif.) and Digital Microsystems (Embarcadero, Calif.). Digital's rotating-screen DMS-5000 (photo) can display

80 characters by 66 lines for a full page of text or, rotated 90 degrees, 132 characters by 50 lines if you want to view a big electronic spread-sheet problem without scrolling as much. Digital's work stations cost from $3,295 to $4,195.

- As floppy discs for microcomputers are shrinking in size [B&B, PS, Oct.], hard, non-flexible discs are changing, too. Sy-Quest (Fremont, Calif.) has introduced a 3.9-in. Winchester disc with either a fixed or removable platter. Most small-computer Winchesters are 5¼ in. in diameter. Sy-Quest's new disc can store 6.38 megabytes, and two drive units fit the space for a standard 5¼-in. floppy-disc drive.
- Price wars are developing in low-end home computers. Atari models gained in distribution as Sears chose them for marketing. TI offers a $100 rebate on its $300 model, and Radio Shack and Commodore have cut prices on theirs. PS

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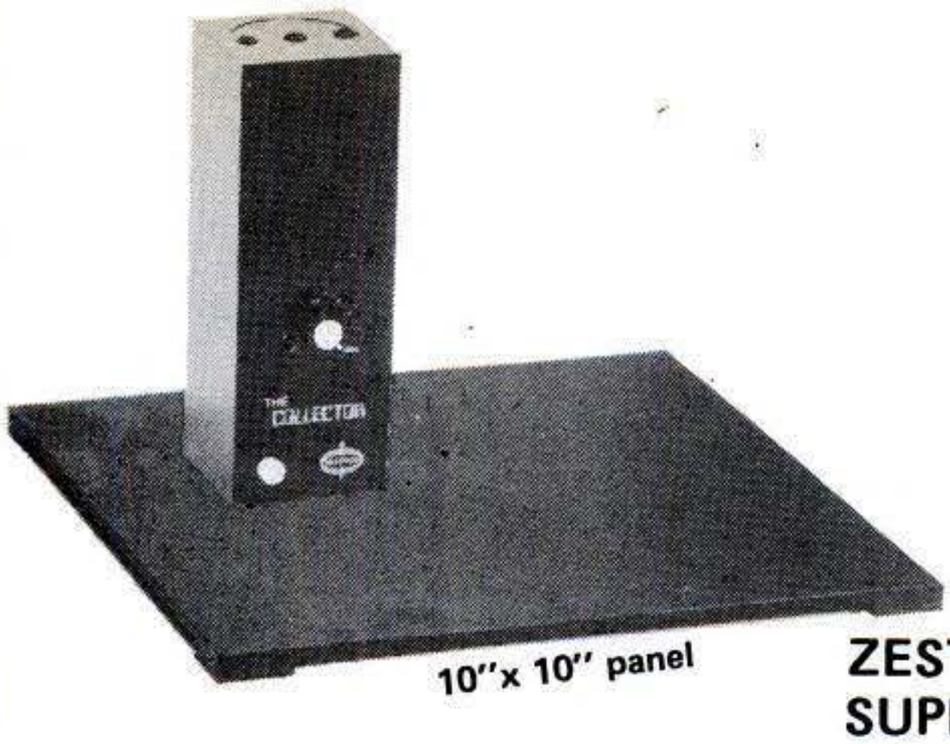

10"x 10" panel

FRESH AIR BREAKTHROUGH!

THE COLLECTOR

ZESTRON, THE LEADER IN ION TECHNOLOGY, ANNOUNCES SUPER-ION OUTPUT IN A BIPOLAR ELECTROSTATIC PRECIPITATOR. "THE COLLECTOR" COMBINES SPACE AGE TECHNOLOGY WITH TRUE VALUE AND PERFORMANCE TO IONIZE AND CLEAN YOUR INDOOR AIR OF HARMFUL, POLLUTANTS BETTER THAN ANY OTHER IONIZER.

IF YOU WANT CLEAN FRESH AIR OR YOU'VE UNPLUGGED YOUR POPULAR FILTER-FAN UNIT BECAUSE IT DOESN'T WORK, THEN READ ON.

Is your indoor air fresh, clean and alive? Indoor air pollution is becoming a national health hazard. Energy efficient airtight buildings are stifled with stale polluted air which includes smoke, dust, pollen, viruses, and bacteria. Most of these pollutants are so small (under 5 micros) that they are not effectively removed by common small filter-fan units. Scientific tests show that these noisy inefficent units which emit chemical "citrus" odors are more like toys, and are no match for high-powered ionizers in thoroughly cleaning the air we breathe.

ANOTHER IMPORTANT DIFFERENCE

You know how good and vibrant the air feels right after a rain storm with that crisp, fresh smell? Just like in the mountains, near a waterfall or at the ocean. That clean, alive fresh air is rich in something important that is missing or greatly depleted in our urban and indoor air. The missing element is negative ions, nature's own air cleaners. *Scientists claim that these amazing active ions are of great benefit to you and can actually make you feel alive, revitalized and alert while relieving depression, headaches and allergies. Negative ions promote sound sleep, learning and healing and even make plants grow better. In addition, hospitals use ionizers in burn units to destroy bacteria and reduce pain.*

Filter fan units do not emit negative ions. The COLLECTOR, by Zestron, creates trillions of these beneficial ions every second, while giving you the best performance, value and technology in air cleaning.

THE ZESTRON BREAKTHROUGH!

Most ionizers clean your air but leave an untidy deposit of pollutants on room and furniture surfaces near the ionizer. The COLLECTOR by Zestron takes ion technology a giant step forward by giving you superpowered ion output while depositing pollutants from your air on the collector panel. This easy to clean panel features a scientifically formulated surface that electrostatically attracts the vast majority of airborn pollutants to it rather than to the floor or walls near the ionizer.

ADJUSTABLE OUTPUT-DETACHABLE COLLECTOR

Some people prefer fewer ions at night. The COLLECTOR is the only adjustable bipolar ionizer that allows you to set the ion level to your personal preference. The detachable COLLECTOR allows you to place it where you want to protect desired surfaces and facilitate cleaning. The scientifically formulated surface instantly wipes clean unlike other bipolar ionizers whose porous surfaces absorb odors and unsightly grime.

AMAZING DEMONSTRATION!

Unplug your COLLECTOR and place a facial tissue on top of the collector panel, then place the ionizer unit and an ash tray on top of the tissue. Place a lit cigarette in the ash tray and watch the smoke rise into the air. Now plug it in, and amaze yourself and friends as the smoke barely rises above the ashtray and then nose-dives into and is absorbed by the tissue before it can enter the room air. This air cleaning is accomplished entirely electronically with no moving parts! The COLLECTOR by Zestron is the only ionizer on the market that cleans the air powerfully enough to accomplish this test.

SUPERPOWER OUTPUT

The COLLECTOR by Zestron is the only bipolar collecting ionizer with superpower output. The thoroughness and speed of air cleaning increases with more ion output, and Zestron ionizers give you the highest output (without detectable ozone). Check the comparison chart below. Don't buy any ionizer not stating output using the industry standard of ions/cc/ sec. at one meter. Low output ionizers generally don't specify output.

IONIZER	OUTPUT (1 m.) ions/cc/sec.	COLLECTOR
The COLLECTOR By Zestron	1,600,000	YES
JSA Bubble	???	YES
Aspen	???	YES
Orbit	???	YES
AirCarell	236,000	YES
ZESTRON IG-700	1,900,000	NO
Ion Fountain	540,000	NO
Ion Cloud	350,000	NO
Ionosphere	350,000	NO
Modulian	75,000	NO
Ion Breeze	???	NO

FREE ION DETECTOR

A FREE remote ion detector comes with each ZESTRON to verify and compare output. When you place the detector next to a ZESTRON and a competitive unit, you will see greatly reduced or no output from the competitive unit!

SILICON VALLEY TECHNOLOGY

The COLLECTOR, incorporating years of high reliability design experience, is built in the heart of Silicon Valley, USA, using quality parts operating under low stress. It is designed to give you space age performance and years of trouble free service. The COLLECTOR operates anywhere in your home or office on regular current for pennies a month. It has no moving parts and nothing to wear out or replace.

THOUSANDS OF SATISFIED USERS

Don't you, your family and friends, deserve the healthy clean fresh air that Zestron ionizers have brought to thousands of satisfied users? Users write:

"I simply cannot believe how much better I feel physically" Dr. E.K., DDS - MA

"I smoke heavily and it has cleared the air as advertised" G.P. - WA

"I haven't taken the top off my nasel decongestant spray since using your product. I was previously a chronic user." G.S. - SD.

When you use your COLLECTOR, you'll quickly feel the difference it makes and smell the freshness in your air. You'll actually see the elimination of smoke and dust in your air!

SATISFACTION GUARANTEED

Order a COLLECTOR now and try it in your home or office risk free for 30 days. You will probably want more units, but if for any reason you are not satisfied, return the unit for a prompt and courteous full refund including your return postage. The COLLECTOR has a full one-year warranty on both parts and labor, excluding abuse.

ADDITIONAL DEALERSHIPS AVAILABLE

Reorders are pouring in, customers write:

"We are enjoying the results of the first one and are ordering two more" Dr. J.B., M.D.-CA

"Very pleased with the first unit . . . send two more" Dr. D.M., D.C. - CA

"I'm a distributor for three other ion companies, and have to say I am extremely, extremely impressed." T.N. - CA.

ZESTRON, the leader in ion technoloy, has created a unique DEALERSHIP PROGRAM. Call or write for details on this RISK FREE OPPORTUNITY.

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NOTICE: Don't be fooled by cheap imitations. These glasses are made exclusively for U.S. Optics®. To make sure you get the best, order now and if not completely satisfied return for refund within 30 days.

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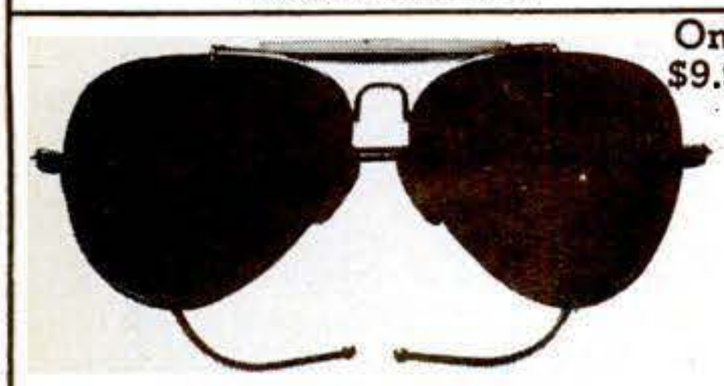
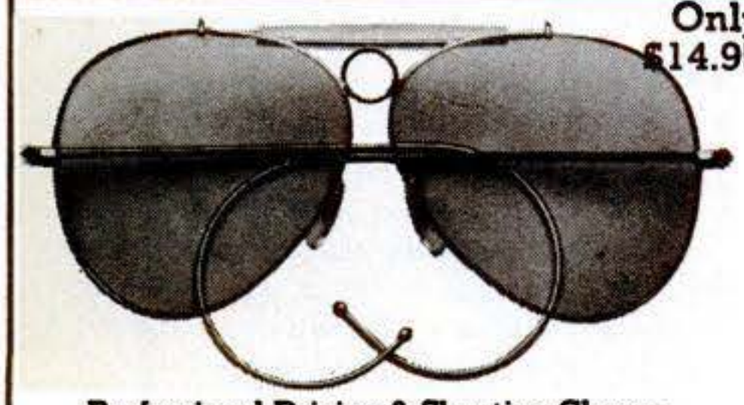
World Famous Pilot's Glasses
These precision flight glasses are now available to the public for only $7.95. If you could buy them elsewhere, they'd probably cost you over $20.00. #20P available in gold or silver frame. A $20.00 value only $7.95. Two pairs for $14.00.



Only $9.95

Aviator Teardrop Flight Glasses
Flexible cable temples. #30A gold frame only. A $30.00 value only $9.95. 2 pairs for $18.00.



Only $14.95

Professional Driving & Shooting Glasses
Wide angle amber lens brightens visibility. #30D gold frame only. A $30.00 value only $14.95. 2 pairs for $28.00.

To order send check or money order to **U.S. Optics, Dept. 617, P.O. Box 14206, Atlanta, Georgia 30324.**
Credit card customers please fill in card # and Exp. date

QUANTITY	MODEL #	GOLD	SILVER	PRICE
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	30A	X		
	30D	X		

Add Postage, Handling, and Insurance $1.00 per pair _____

Total _____

Credit card orders may call 1-404-252-0703.

Visa or Master Charge # _____ Exp. Date _____

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FREE case with each pair.

Camera chip
senses TV images in total darkness

Television engineers flood studios with intense light so TV cameras can sense picture details by the light that objects reflect. RCA now says it has developed a solid-state infrared camera that creates recognizable TV pictures in a room that's totally dark to the human eye.

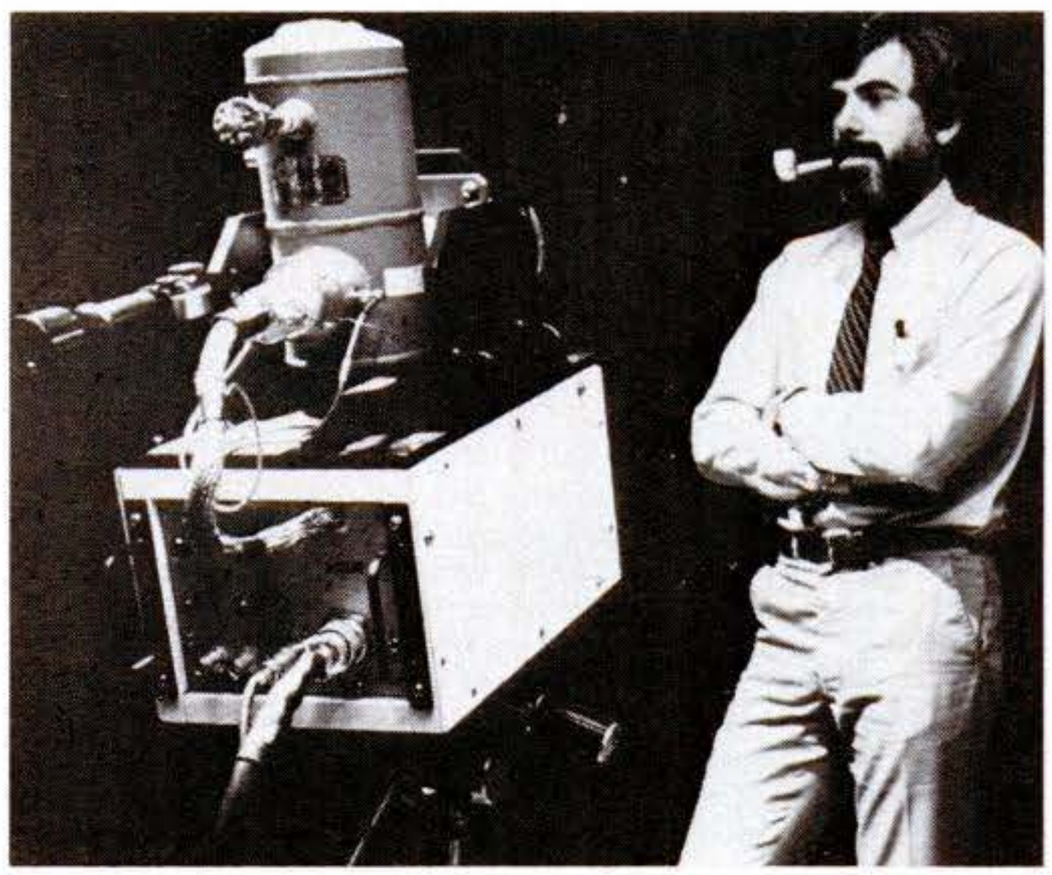
Pictures with RCA's experimental camera are a long way from commercial TV standards. But the recent advance in imaging technology suggests it has the potential to approach broadcast-television resolution.

Pictures are seen by the infrared radiation that strikes the camera sensor. During a demonstration of the RCA device, the camera was able to discriminate veins in a human hand and detect the heat transferred to objects when they were touched by someone for only one second or less.

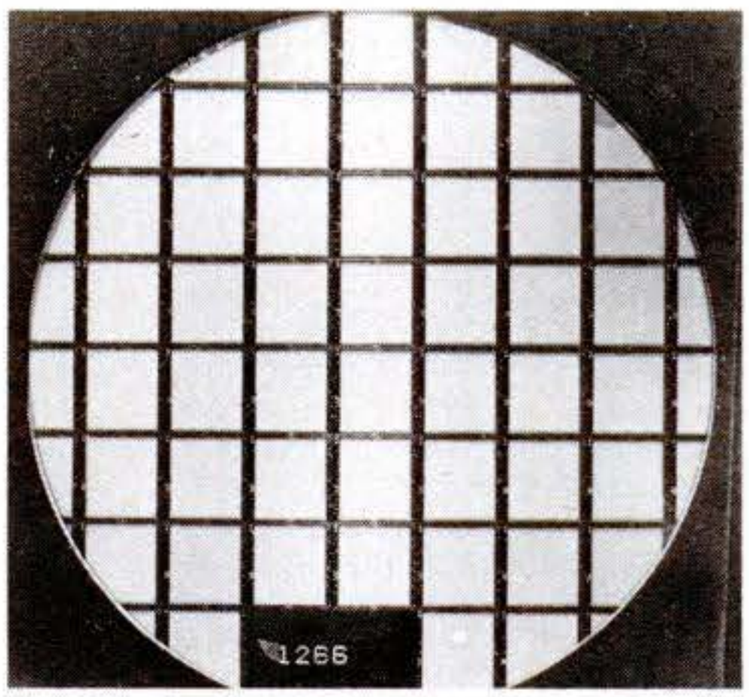
Chips used in the camera are cooled by liquid nitrogen. They're sensitive to spectral wavelengths of three to six micrometers. And though the sensors—platinum silicide Schottky-barrier detectors—are still relatively inefficient, they're 10 times better than an earlier type made with the same material.

A detector has 8,192 elements, arranged in a matrix of 64 columns and 128 rows. The chip is a charge-coupled device [PS, Jan.] that functions like sensors in conventional solid-state cameras.

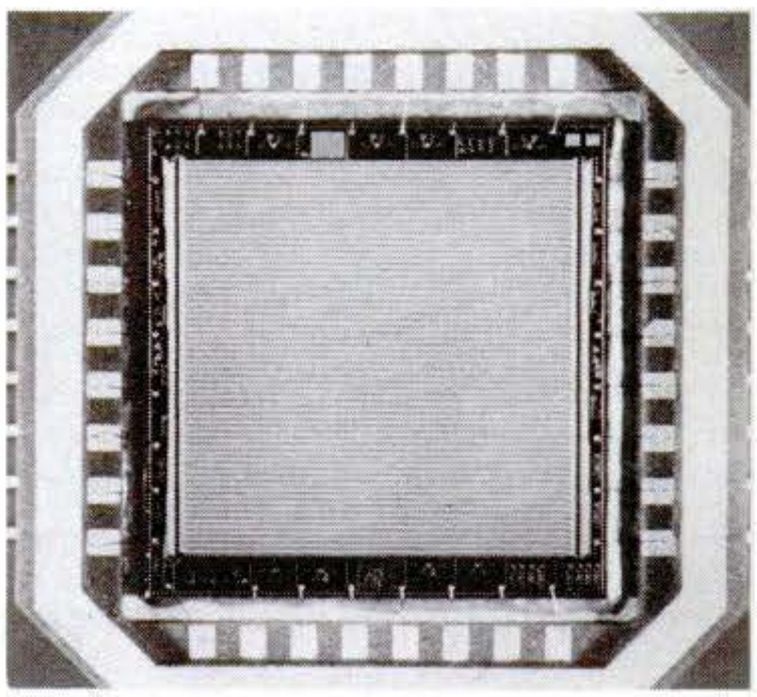
RCA's technique of depositing exceptionally thin films on a substrate has also made the uniformity of response much better than with other infrared sensors.—*John Free*



Thermal image on TV monitor above is made by RCA's experimental heat-sensing camera (left). Warm objects, like scientist Gary Hughes' skin, appear white in total darkness; cool ones, dark.



Three-inch silicon wafer has a number of infrared-sensitive chips. Wafer is made by depositing a very thin film of platinum silicon over the substrate.



Dime-size imager chip sliced from a silicon wafer has over 8,000 heat-sensitive elements. Each of these picture elements is 120 by 60 micrometers in size.

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It had no digital readout, an ugly case and a stupid name. It almost made us sick.

You'll love the way we hated it until an amazing thing happened.

Love/Hate Thermostat

You're probably expecting our typical sales pitch, but get ready for a shock. For instead of trying to tell you what a great product the Magic Stat thermostat is, we're going to tear it apart. Unmercifully.

When we first saw the Magic Stat, we took one look at the name and went "Yuck!" We took one look at the plastic case and said "How cheap looking." And when we looked for the digital readout, it had none. So before the salesman even showed us how it worked, we were totally turned off.

REAL LOSER

So there it was—at first blush a real loser. But wait, we did find one good feature—a feature that led us to a discovery. The Magic Stat installs in a few minutes and no serviceman is required. Thermostat wires in your wall follow standard color codes. So when you install a Magic Stat, you attach the red wire to the red location and the white to the white. That's playschool stuff. And it's safe. Conventional thermostats installed over the past 20 years are generally only 24 volts, so you can either turn off the power or work with the "live" wires without fear.

OK, LET'S TEST IT

The Magic Stat installation was so easy that the least we could do was test it. And that's when we made an incredible discovery. We discovered that the Magic Stat was probably the most consumer-oriented, technologically-advanced and most sophisticated thermostat ever developed on the face of this earth and in our galaxy for all times ever. What made us switch from hating the thing to loving it? Read the following.

The Magic Stat has six setback settings per day and a seven day program. That means that you could set it for 70° when you get up in the morning, drop the temperature to 54° when you go to work, raise it to 68° when you return for dinner, raise it up to 72° after dinner as you watch TV and then drop it down to 62° when you go to sleep. Count them—five settings with one to spare.

In one day the Magic Stat is programmed for the whole week and for the weeks to come. If you want a different schedule for weekends, you can individually program the thermostat for those days, too. "Big deal," you might think. "What's so great about that?" Read on.

You set most electronic setback thermostats to the time you want the furnace to go on in the morning, so when you wake up, your room is once again warm. But what if one morning it's bitter cold outside and the next morning it's much warmer? This means that setting your furnace to go on at the same time may, on one morning, leave you cold and on the next morning cause you to waste energy by warming up your house too soon.

By golly, the Magic Stat has everybody beat on this one too. Throughout the night it senses and computes the drop in temperature and the time it will take to get your room to your exact wake up temperature. So if you want to wake up at 7 AM to 70 degrees—that's the temperature you'll wake up to every time. Because it's a patented concept, no other thermostat has this feature. But wait. There is also a patent on the setting feature.

SIMPLE TO SET

To set the thermostat, you press just one button. A small LED light scans the temperature scale until you reach your desired temperature and then you release the button. You change the temperature naturally, throughout the day, up to six times. The unit responds and remembers that exact living pattern. The present temperature is displayed by a glowing red LED on the temperature scale.

The system also computes the ideal length the furnace should stay on to keep the temperature within a range of plus or minus one and one-half degrees. A battery backup lets you keep your stored program in its memory so power outages as long as eight hours won't let your unit forget. And if something happens and your power is out for a few days, the unit will automatically maintain 68 degrees when the power is restored.

Quite frankly, we were so impressed with the unit, its ease of installation and setting plus its many energy-saving features, we seriously considered advertising it until we realized that our customers would probably not want to trust their future comfort to a product called, Magic Stat. What if something went wrong with the unit? How substantial was this Magic Stat outfit? Remember, a thermostat is something you live with as long as you live in your home, and they're supposed to last ages. After all, your comfort depends on it.

Well, we did our homework. We found the company to be a sound, well-financed organization. They have been in business for several years, and they back their products with a three-year limited warranty. In addition, the company has a policy of buying back your unit in one year if you haven't saved its full cost in energy savings. We were satisfied with the company, the people, the product, its incredible features, the company's commitment to the product and above all, the real energy savings possible.

We are so impressed now with the Magic Stat that we're going to make buying one irresistible. Buy one from us for only $79.95. Install it yourself in a few minutes or hire a handyman to install it.

ENJOY SAVINGS

Then enjoy the savings this next winter. Not only will you save up to 30% on your heating bills, but you're eligible for the 15% energy tax credit. Then if you're not absolutely in love with this product one year later, return it to JS&A. You'll get all your money back and you can reinstall your old thermostat.

But we're counting on a few things. First, you will realize an energy savings and a comfort that will far surpass what you are currently experiencing. Secondly, you probably will sleep better breathing cooler air yet wake up to just the right temperature.

Beauty is only skin deep and a name doesn't really mean that much. But we sure wish those guys at Magic Stat would have named their unit something more impressive. Maybe something like Twinkle Temp.

To order, send a check or money order to the address below or credit card buyers call toll-free 800 228-5000. Use order number (shown after price). Add $3.50 for postage and handling. (Ill. res. add 6% sales tax.)
Magic Stat **$79.95** (0040 PS02)

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5.	Snackman (Better than Packman)	$19.95	$15.95
6.	Bug Blast (Creepy)	$19.95	$16.95
7.	Anti Matter Splatter (Nuclear Disaster)	$24.95	$19.95
8.	Bombs Away (Great)	$18.95	$15.95
9.	3-D Maze-Escape	$16.95	$14.95
10.	Krazy Kong	$16.95	$14.95

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Portable computer features permanent memory

Settle into your airline seat, remove your computer from a briefcase, and get to work. Use Epson's new HX-20 portable computer as a mini word processor for memos or reports. Call up a financial program to update forecasts. Run scientific or engineering calculations. Or just play a quiet game or two.

Those are just a few of the uses you'll find for this new battery-powered personal computer. The HX-20 is small enough to go anywhere yet just large enough to have a full-size keyboard. Its advanced design and "permanent" random-access memory, based on microcircuits that draw only trickles of power, make the HX-20 one of the most innovative new computers on the market.

Epson's new model weighs 3.2 pounds and measures just 11.5 by 8.5 by two inches. The HX-20 comes with 16K (kilobytes) of memory (expandable to 32K) that is never turned off, liquid-crystal display screen, and built-in printer. The suggested price: $795. The machine has ports for adding disc drives, a printer, video monitor, external cassette recorder, modem (for phone hookups), and bar-code reader.

The built-in printer is a mini-version of Epson's popular larger model. A tiny impact head and ribbon delivers 24-character dot-matrix lines. One drawback: You only see four lines of 20 characters each on the liquid-crystal screen. Standard line lengths are actually 40 characters, software adjustable out to 255 characters, which can be viewed by horizontal scrolling.

You can replace a dummy cartridge in the case with either a removable microcassette unit to load programs from tapes or 16K read-only-memory (ROM) module. Another 16K ROM chip can be installed on the internal circuit board.

The ROM capability enables frequently used programs to be permanently installed inside the HX-20 or plugged in externally. Epson (3415 Kashiwa St., Torrance, Calif. 90505) expects HX-20-compatible software to begin appearing in early 1983.—*Jim Schefter*

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AKAI

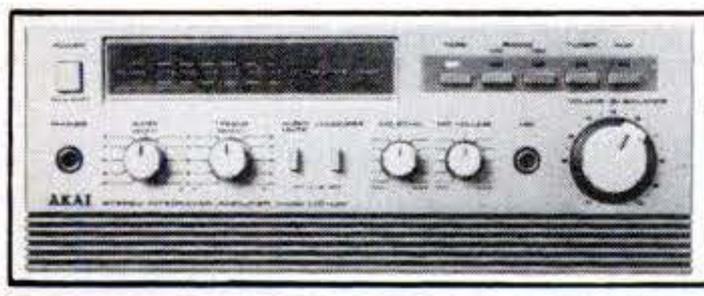
Thanks to some fancy international negotiations, C.O.M.B. Co. has been able to acquire the entire remaining inventories of these AKAI Mini Component Systems from Japan. The 1983 models may be in the works, but these are brand new, PERFECT condition, factory warranted 1982 models! Now you can enjoy the incredible quality of AKAI at an incredible HALF PRICE!

Centered around the 45 watts per channel power of the STEREO INTEGRATED AMPLIFIER, this high-performance mini-system combines sophisticated technology with deluxe looks. The controls have been strategically positioned for smooth, one-touch operation. Large LED optical indicators provide visible aid in controlling the various functions.

The QUARTZ SYNTHESIZER TUNER features memory preset of up to 20 separate broadcast stations. It can also be used to seek out broadcasts automatically at a touch with scan tuning.

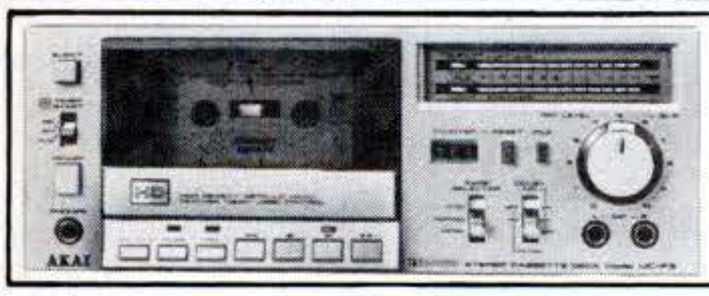
The Dolby Noise Reduction equipped STEREO CASSETTE DECK operates with feather-touch logic controls and can record on the new high-density metal tapes for superb reproduction.

The 2-WAY SPEAKER SYSTEM delivers sparkling clarity at any volume. The speakers are only 9½" high. Sound is delivered through a 4" cone woofer and a 1" dome tweeter. Features rigid wire-mesh grille and deluxe silver finish.



STEREO INTEGRATED AMPLIFIER — Who ever heard of such massive power from such compact dimensions? But it's true! This amplifier puts out 45 watts per channel into 8 ohms, with an inaudible 0.02% harmonic distortion. High-performance power stage employs direct-coupled circuitry for low-noise, low-distortion sound. Click-stop bass and treble tone controls provide positive operation. There's a built-in head amplifier for moving coil cartridges, too. Also features loudness compensation, 2-rows of LED power indicators, audio mute facility and mic mixing input with adjustable echo. 11"W x 4.3"H x 11"D. Weighs just 17 lbs.

QUARTZ SYNTHESIZER TUNER — Get automatic station selection at a touch! No more dial to turn! Tune in any station directly by simply pressing calculation-type keys. (If you want 87.4 MHz, just press 8, 7 and 4.) Recall instantly 10 AM and 10 FM stations that you can program into memory. Very clear reception quality! 11"W x 2.2"H x 11"D. 6.25 lbs.



STEREO CASSETTE DECK — Deluxe feather-touch logic controls require only slight pressure to activate operation and provide "fail-safe" electronic switching between modes. The mechanical stability is evident in the 0.05% (WRMS) wow and flutter. You'll be assured of outstanding recordings from any tape variety! Optical LED bar graph meter accurately tracks input signal levels to help you make professional sounding recordings. The Instant Program Locating System lets you quickly rewind back to the start of a tune or skip forward to the next tune on the tape. Dolby equipped. Measures 11"W x 4.3"H x 10.6"D. Weighs just 11 lbs.

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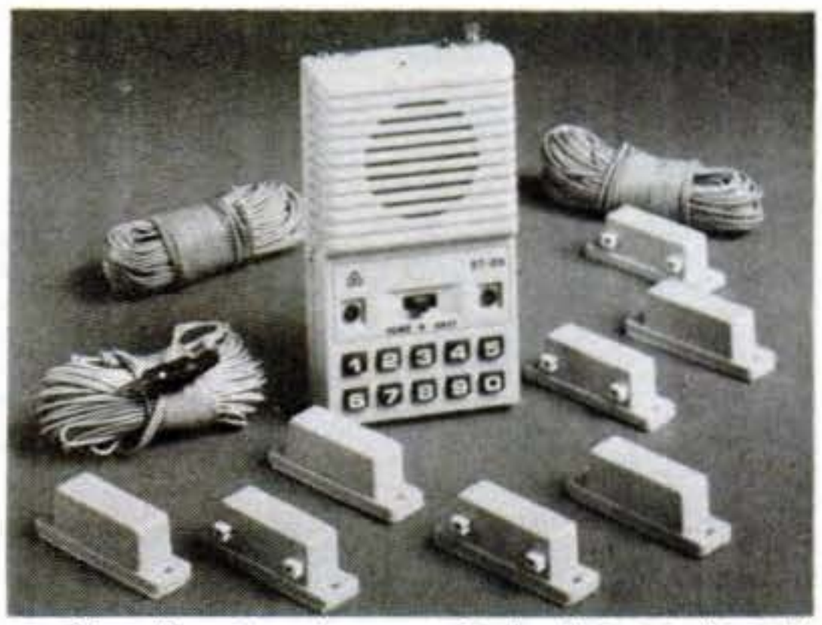

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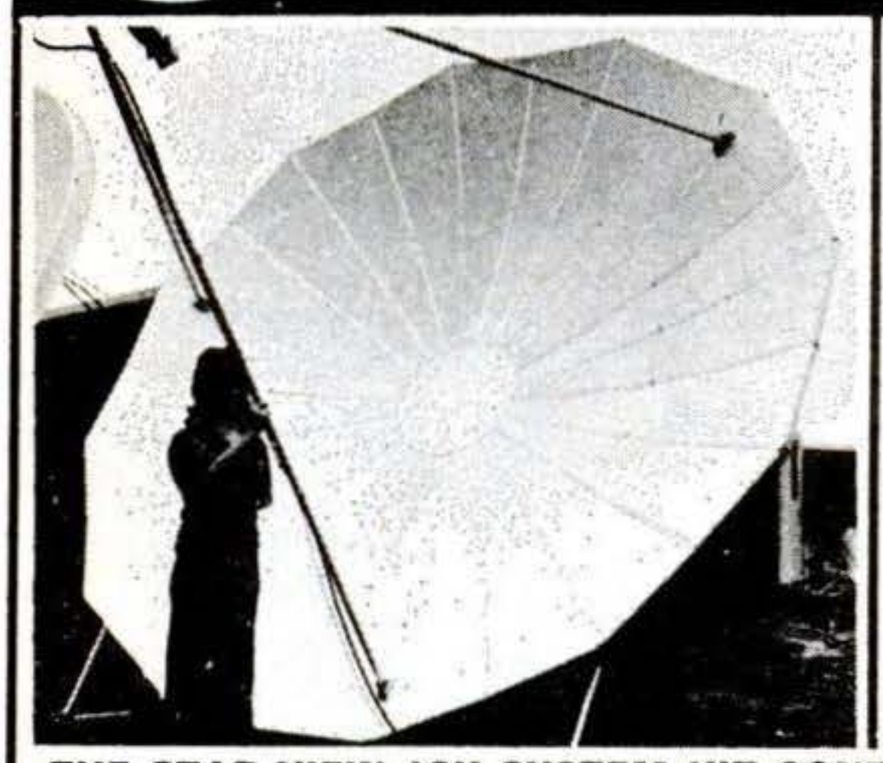

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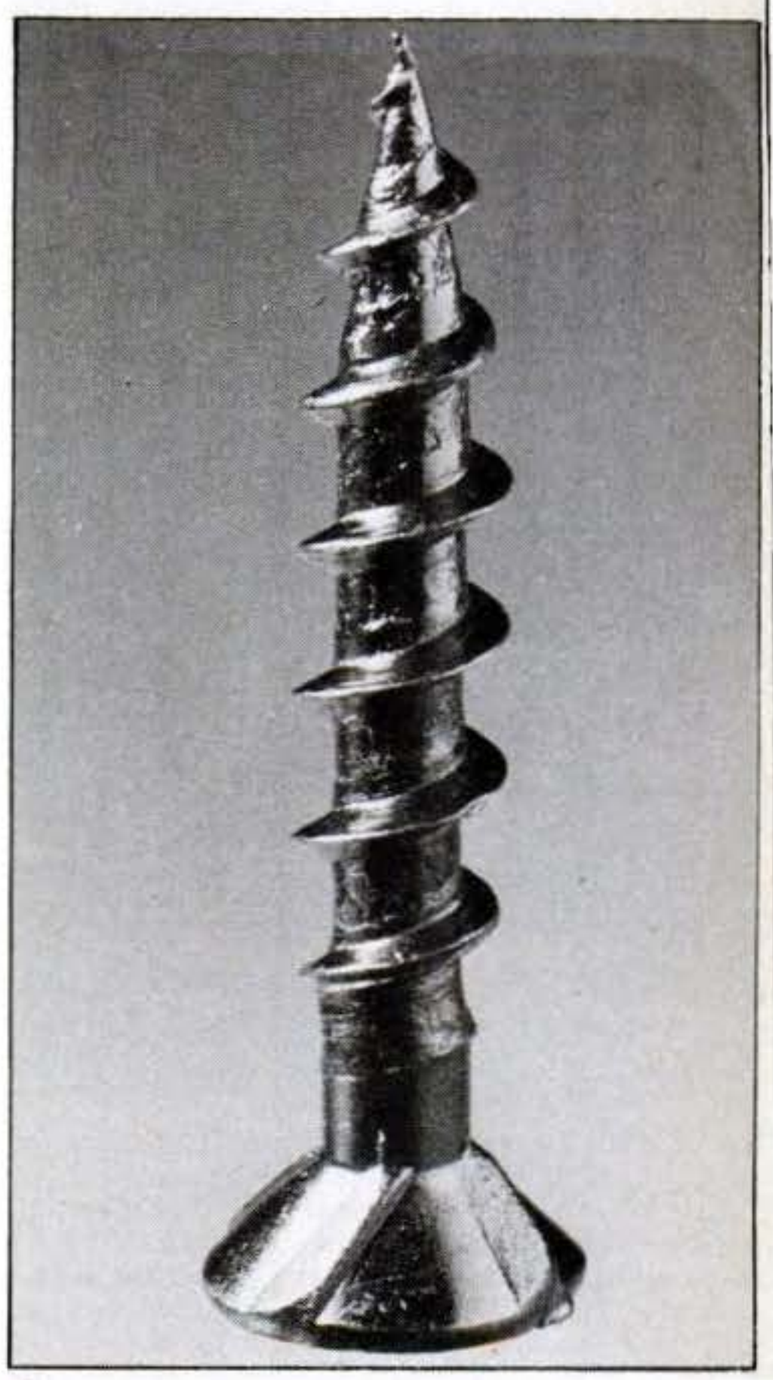
New screw has built-in countersink



Sharp nibs on the head of the Sinker screw, plus specially designed threads, let you power-drive it into particleboard.

You can drive hardened screws into most woods without countersinking ["Power Screwdriving," PS, May '81]. The combination of a tough screw and your power driver will let you sock the head down flush with ease.

It will, that is, unless you're working with particleboard. This stuff is so hard you'll probably strip the screw—or snap its head off—before you can sink it flush.

Now there's a new screw called the Sinker from Equality Screw Co. (Box 1296, El Cajon, Calif. 92022) that solves this problem. Special nibs formed into the underside of the head act just like a built-in countersink, cutting a recess for the head as you drive the screw. You can set it flush or even drive it well below the surface if you want to cover the head.

In addition to the special countersinking head, the screw also has the steeply pitched, widely spaced threads required for a good bite into particleboard.—*A. J. Hand*

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TS-3000

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THERMOMETER THE WORLD'S FIRST!

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This underwater genius makes even he fanciest watches seem ordinary. It not nly provides you with an electronic ermometer, but gives you three alarms, 2/24 hour time, a full-function topwatch and more.

Introducing the CASIO **TS-3000** hronograph. Priced at only **$79.95** and vailable only through ON THE RUN.

WORLD EXCLUSIVE – EMPERATURE READOUT

CASIO engineers have gone one step urther in their line of gifted marine igitals. They've built a 100-meter alarm hronograph that measures temperature n Celsius and Fahrenheit (– 10°C[13°F] o 60°C[140°F]) in or out of water.

Imagine a timepiece that tells you the emperature simultaneously with time or topwatch. And allows you to set a hermo alarm to tell you when water or urroundings are too hot or too cold.

It's ideal for sportsmen or anybody who wants to know the temperature, in or out-of-doors, in an instant.

TOPWATCH, 8 TIME ZONES ND 3 ALARMS –

The push of a button sets into motion a fiercely talented stopwatch. You get a ull-function 1/100 second stopwatch hich repeats every hour.

In addition to regular timekeeping (in 12- or 24-hour selectable format), you et 8 time zones! Tokyo, Honolulu, San ancisco, Chicago, New York, London, Paris and Moscow. This function is especially useful for travelers, domestic nd foreign. Hours, minutes and seconds re displayed with reliable ± 15 seconds month quartz precision. In addition to a hermo alarm, you also get a daily wake-up appointment alarm and an hourly alarm. Of course, all can be silenced with a touch of a button. Press another button, day and date appear. And another for a built-in night light powered by a long-life lithium battery.

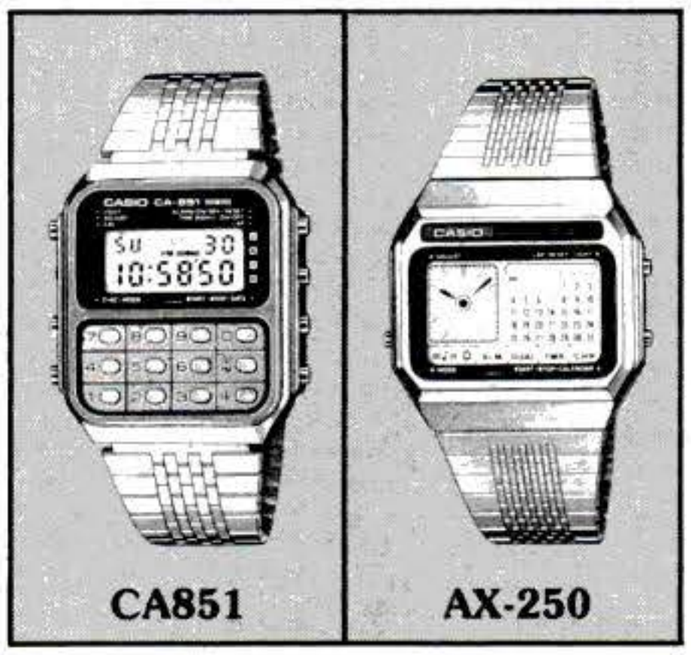
TWO STYLES AVAILABLE

The good-looking stainless steel **TS-3000** is available for only **$79.95.** Or for only **$49.95** the all black polysulfone model **TS-1000.** So lightweight and comfortable, you may never realize that you're wearing the most advanced underwater watch on the market today. Both models are rugged and withstand water in any form — sweat, rain or total submersion.

TWO OTHER TOP CHOICES

CALCULATOR, VIDEO GAME, ALARM, CHRONOMETER

CASIO's new calculator watch is not only a masterful problem solver, but an entertaining video game as well! "Counterattack" tests your reflexes as you destroy enemy missiles, increasing your skill level as you go. When you're not under attack, you'll be able to use its 8-digit calculator with constants, powers, mixed and recipricol calculations. A full-function 1/100 second stopwatch is standard as well as two time zones, 12/24 hour time, day of the week, date and a built-in night light. This mathematician also gives you a wake up/appointment alarm and an hourly chime. Available in all-stainless steel model **CA851** for **$69.95** or the featherweight polysulfone model **CA86** for only **$34.95.**



CA851 AX-250

OWN A DIGI-ANA CALENDAR WATCH

This multi-talented timepiece by CASIO gives you the convenience of watch hands (analog) and the abilities of digital. These watch hands are *electronic* — no moving parts — giving you minimal maintenance and great accuracy. This wonder allows you to view two time zones at one time in either 12- or 24-hour time and also features a daily alarm with your choice of "Dixie", "Clementine", or "Greensleeves". And reminds you of noon with a "Big Ben" chime. A full-function 1/100 second stopwatch and graphic countdown timer are standard. A press of a button brings forth this month's calendar. Another press and you have next month's. Another and you get year, month, date and day. Available in dressy chrome model **AX-250** for **$48.95** or featherweight polysulfone model **AX-5** for only **$38.95.**

OUR DOUBLE GUARANTEE

First, the included warranty: One-year parts and labor (in the rare event repair is needed, you'll find this service by mail feature very convenient).

Secondly, we guarantee your satisfaction. If not delighted with your CASIO, return it in new condition within 30 days for a full refund.

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To order your watch, call the toll-free number below, or send a check or money order for the total amount **plus $2.50** for the first watch, $1.00 for each additional watch to cover shipping and insurance costs. For an additional $2.00 we will ship your watch via U.P.S. **2ND DAY AIR** air delivery. North Dakota residents add 3% tax.

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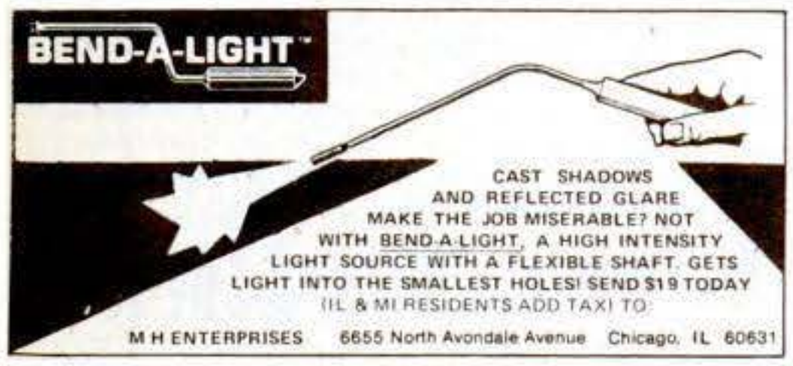

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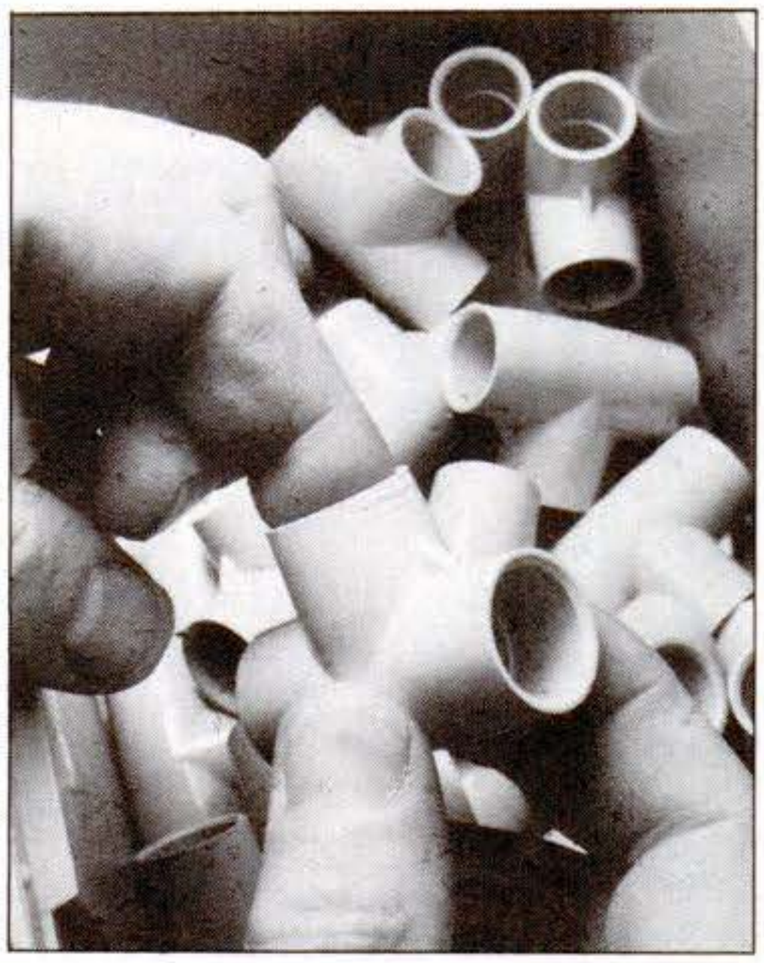
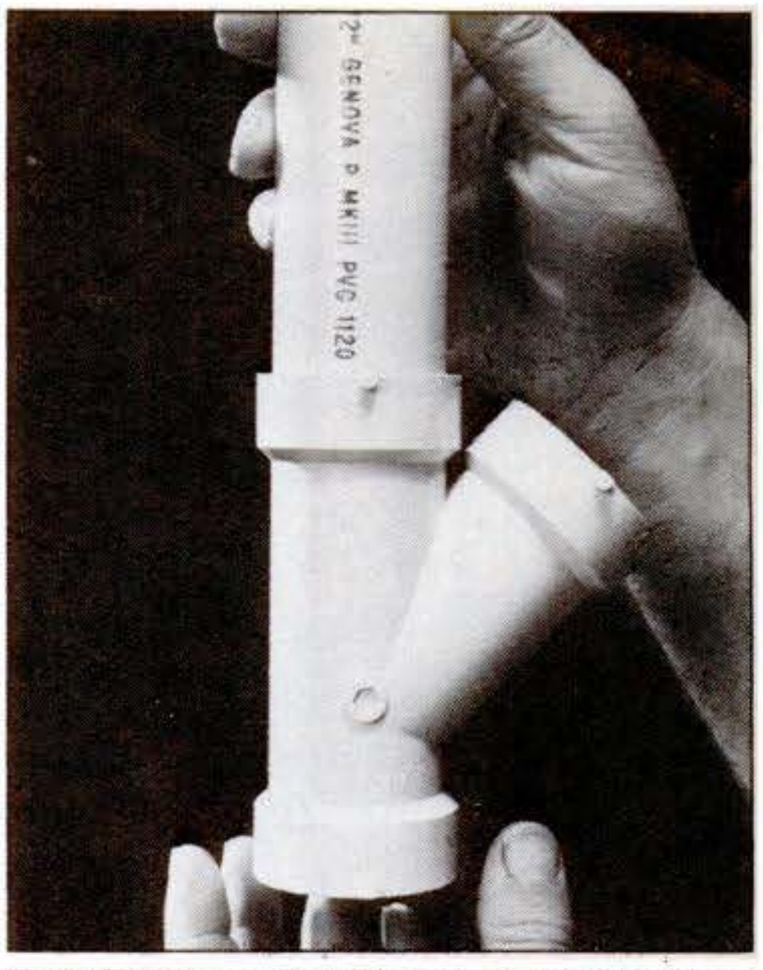
Plastic plumbing

[Continued from page 85]



Feel around insides of fitting sockets to ensure that solvent welding surfaces are smooth. Inspect threaded fittings, too.



Test-fit pipes and fitting before buying. Pipe should fit snugly so that it doesn't bottom out or fall off when it's inverted.

line the insides of dishwashers. That's why it is also the material of choice for the most vulnerable part of your home plumbing system: the sink trap.

You will find traps made from other materials, too, including PVC and ABS. ABS suffers from intergranular stress cracking, in which contact with animal fats or vegetable oil can suddenly relieve molecular stresses created in the molding process. It happens like an earthquake on a molecular scale. PVC and PP traps are resistant to stress cracking.

If all of this doesn't have you confused already, then consider the variety of colors, sizes, and joining techniques available. Pipes and fittings may be black, beige, white, milky, or other colors. Some materials use a two-step solvent-welding process [PS, Jan. '81], some a one-step. Others require mechanical couplings, barbed clamps, or slip-jam nuts. Sizes are derived from the conventions used for metal pipes. Thus PE and PVC are designated like iron pipes, by their inside diameters, and PB and CPVC lines are usually measured by their outside diameters, as is copper tubing. Just make sure that the pipe and fitting sizes you buy are compatible.

Now that you know the apples from oranges, keep remembering bananas when you go to the store. Be suspicious of every part you see; any of them may be defective.

Here are some of the common problems you're likely to encounter. Flash—ragged webs of superfluous plastic—is characteristic of all injection-molded plastic parts. The tiny spaces between parts of the mold fill with molten resin, which solidifies when cooled. Flash on the solvent-welding surfaces of a fitting can affect the joint. Flash on the insides of a fitting can impede flow. Quality fittings have the flash trimmed off.

The same is true for sprues, solidified fill holes where the raw plastic entered the mold. Most sprues are located on the outside of the fitting, where a small projection hurts noth-

Pipe of choice for hot-cold water supply

Use	Rigid CPVC	Flexible PB
Fixture drops (air chambers, etc.)	Best	Too many costly fittings
Fixture branches (off mains)	Best	Many costly fittings
Hot-cold mains, outdoor hose bibbs	Best for shorter runs	Best for long, fitting-free runs
Exposed in basements, utility rooms	Best	May look unworkmanlike
Service entrance, between-floor risers, garage branch	Too many fittings	Best; done with few fittings
Plumbing remodeling work behind existing walls	Difficult to run	Best; may be threaded behind walls
Around obstacles	Too many fittings	Best; done without fittings
Shower riser pipe	Best	Offers no support for shower arm
Bath/faucet pipe to spout	Not enough support; use a metal pipe	No support; use a metal pipe
At water heaters, softeners	Excellent (use proper transition fittings)	Excellent (use proper transition fittings)

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ng but the appearance. Some manufacturers use inside sprues, however—a bad practice. If not ground off flush, an inside sprue forms a waste catch.

With threaded fittings, look out for poorly formed or shortened threads. Avoid using female plastic fittings with metal pipe. Plastic expands at a faster rate than the metal it's threaded onto; since it expands away from the metal, leaks are bound to result.

Beware of color variations between fittings of the same brand. These warn that the manufacturer's resin-mix control was haphazard. Be especially careful when buying white CPVC or PVC, whose natural color is beige. Manufacturers sometimes add chalk to extend the resin, but this weakens the plastic. Burned spots, dirt showing in the material, and surface roughness are other indicators of poor procedures at the factory.

Many do-it-yourselfers will still feel overwhelmed when confronted by plastic pipe in the store. Home plumbers need all the help they can get in selecting pipes, fittings, and solvent cements, but too few stores offer it. In that Detroit-area store, for example, I found pipes and fittings in white, black, gray, and beige, but no signs identified the plastics. Also, the store featured an extensive line of solvent cements varying considerably in price, but no information directed me to the proper cement for the job. If I had been a price-shopper, I might have chosen the cheapest cement and taken home a material that wouldn't work on my piping.

That's one extreme. At the other is the store with displays that clearly identify pipes and fittings and explain how they are used. The solvent cements to use with each are indicated. If you are really lucky, a clerk who understands plastic plumbing materials is available to advise.

Once you select a brand of materials, stick with it. Buying a pipe by one manufacturer, a fitting by another, and a solvent cement by a third is no route to quality plumbing. When all parts are made by the same firm you know that they were made to fit together and the solvent cement was formulated to work with them.

Don't just rely on a familiar name, though. Check for an ASTM number on each pipe and fitting. That means the part conforms to the standards established by the American Society for Testing and Materials. In water-supply piping, also look for the National Sanitation Foundation's "NSF-pw" approval, meaning parts are suitable for potable water. PS

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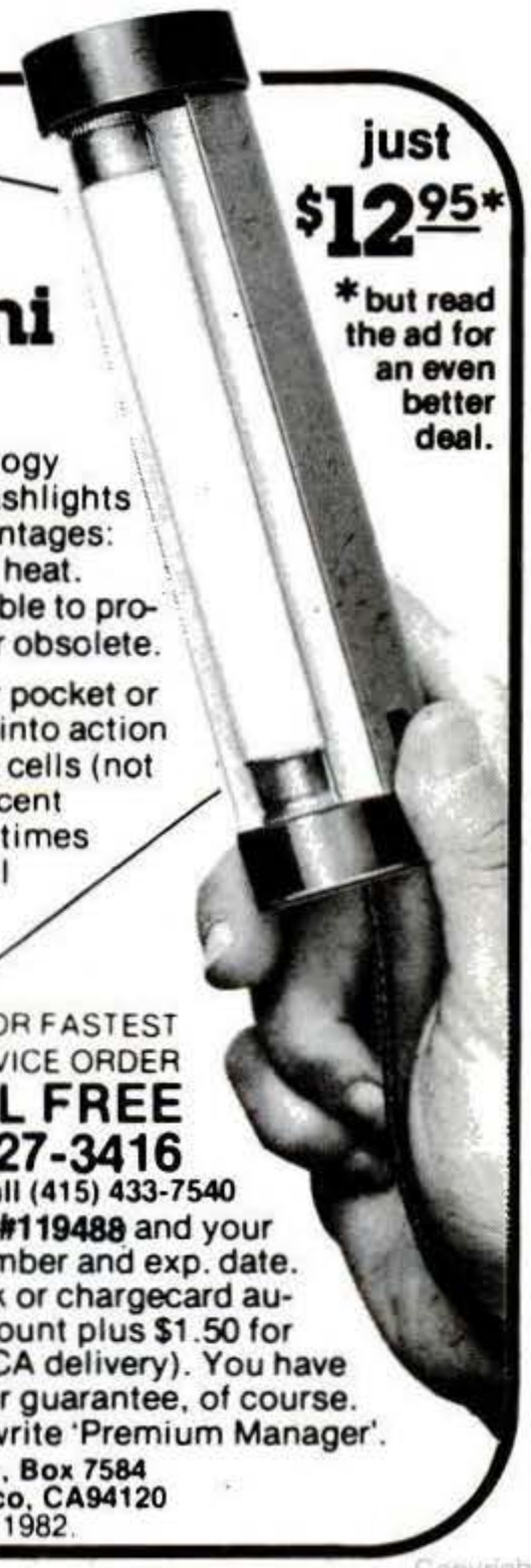

just $12.95*
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Until quite recently, it was impossible to harness the technology of fluorescent lighting into a small flashlight. Almost all flashlights were of the "standard" incandescent variety, with all its disadvantages: low light output, high battery drain and production of wasteful heat. With the advent of transistorized circuitry, it's now finally possible to produce a small fluorescent flashlight that literally makes all other obsolete.

The *Super-Mini* is only an incredible 6" short. It fits in your pocket or in a tiny purse. At the flip of the switch, the *Super-Mini* springs into action producing bright area illumination. The lamp works on four AA cells (not included, but available anyplace). The drain of the cool fluorescent tube is so small (only 4 watts) that batteries will last about five times as long as in a "standard" flashlight. And the 4-inch tube will virtually last forever. But if you break it or if anything else happens to it, replacement is readily available.

Another "minor miracle" may well be the price. More ponderous fluorescent lamps sell for $19.95 or more. We sell the *Super-Mini* at an astonishing $12.95. But there is an even better deal: Buy two for $25.90 and we'll give you a third one as a present. We would like for you to have the *Super-Mini* so as to acquaint you with our unique merchandise and with our fine service. It is one of the most attractive and useful devices we have ever offered. Order your *Super-Mini* today!

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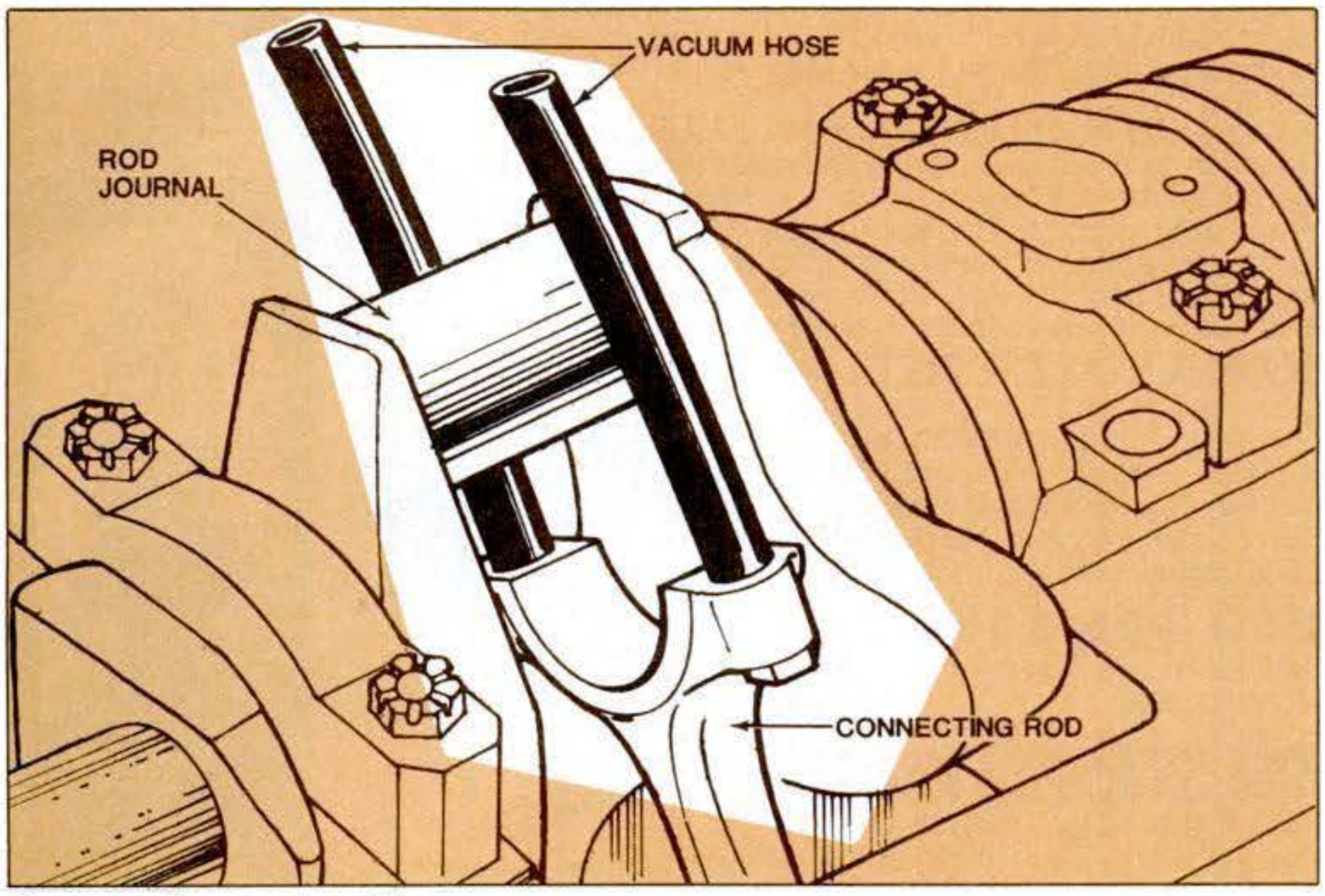
TAKING CARE OF YOUR CAR

By STEVE MERCALDO

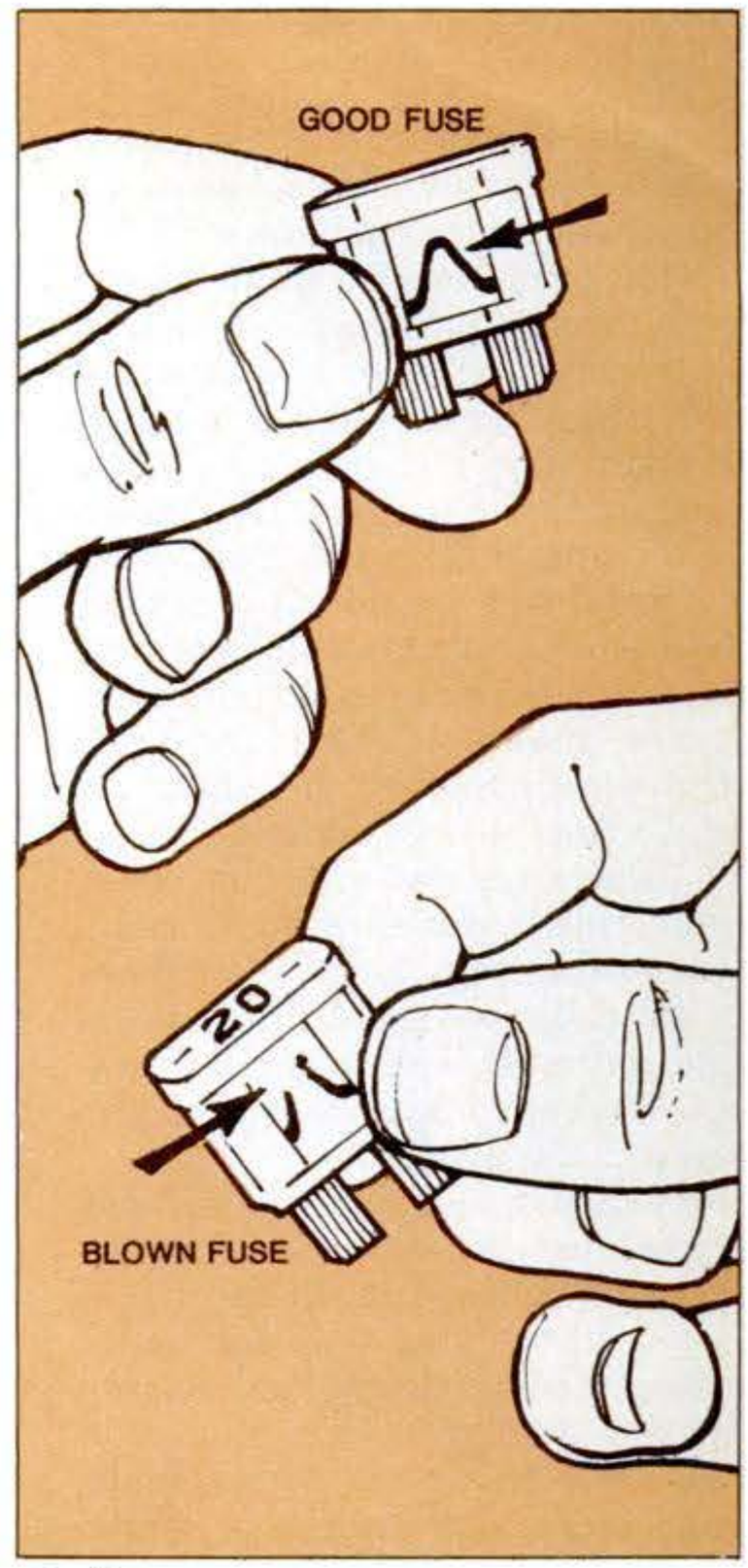
Got a useful car tip? Send it (with Social Security No.) to Car Care, POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. We'll pay $50 if we use it. If two or more readers send the same tip, payment goes to the one with earliest postmark. No tips can be returned.



Connecting-rod guides

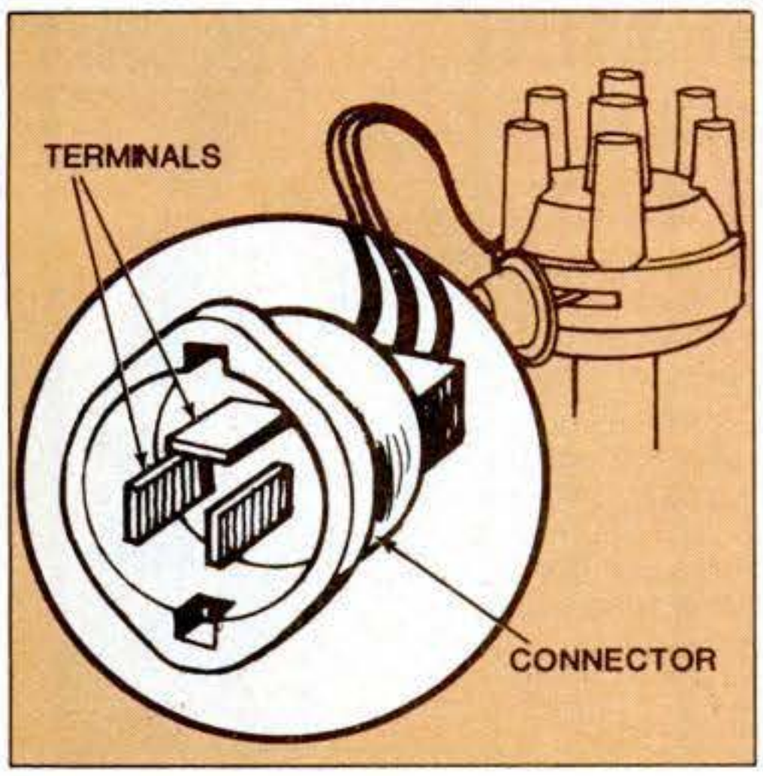
Replacing a piston assembly usually requires an extra pair of hands to guide the connecting rod carefully onto the polished crank journal. If there's no help available, try this convenient method.

Install two 12-inch pieces of vacuum hose on the connecting-rod bolts. As you position the assembly in the cylinder bore, allow the hoses to stand loosely on either side of the journal. When you install the assembly into the cylinder, the hoses will guide the connecting rod onto the journal, as well as provide protection for the polished crank-pin surface. Once the rod is close to the journal, slip off the hoses and install the cap.



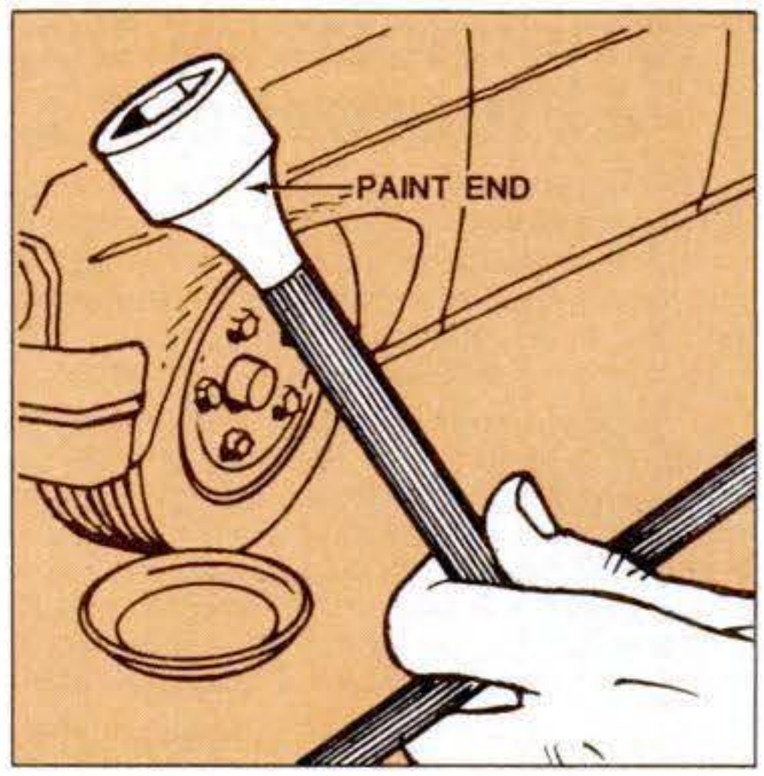
Checking a new-type auto fuse

Many manufacturers have switched to a new type of fuse to protect their cars' electrical circuits. To check this type, simply pull the colored body out of the fuse block and look through the side at the thin metal strip. Always replace a blown fuse with one of equal value. Each fuse carries a number indicating its amp value.



Ignition gremlins

Intermittent electronic-ignition problems are often caused by faulty electrical connections. Try this procedure before replacing expensive electronic ignition parts: First locate each connection in the system. Then disconnect one connector at a time and clean the terminals with fine-grain sandpaper. Tighten loose terminals with a suitable tool and coat each terminal with an electrical lubricant.



Speedy tire changes

A cross-rim-type lug wrench makes changing tires a snap. However, you may try all the wrench's other sizes before you find the right one for your car. To eliminate this and possibly stripping the faces off the lugs, try this trick: Spray your car's exterior color on the correct-size socket. If the wrench is used on two vehicles with different-size lugs, spray the appropriate color on each size.

Probing electrical problems

The wiring on most late-model cars terminates in a plug or connector. This makes it difficult to make voltage and continuity checks because there are no bare terminals to which the test probe can be applied. In these cases, pierce the wire's plastic insulation with a map pin or a sharpened test probe for easy testing. You can protect your fingers with a short piece of heater hose as shown.

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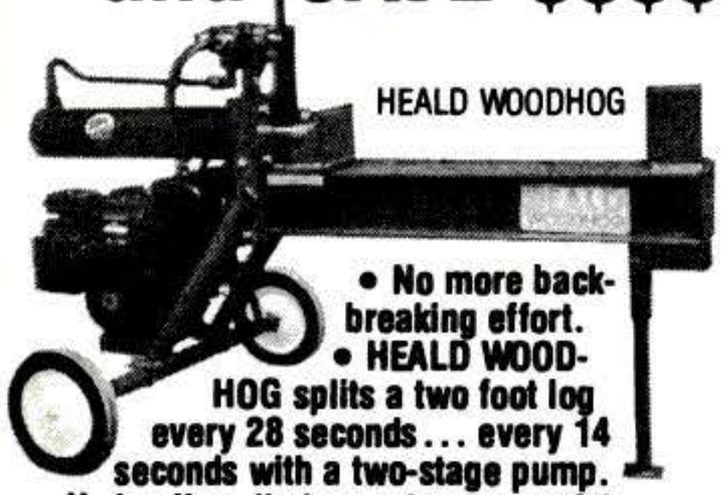

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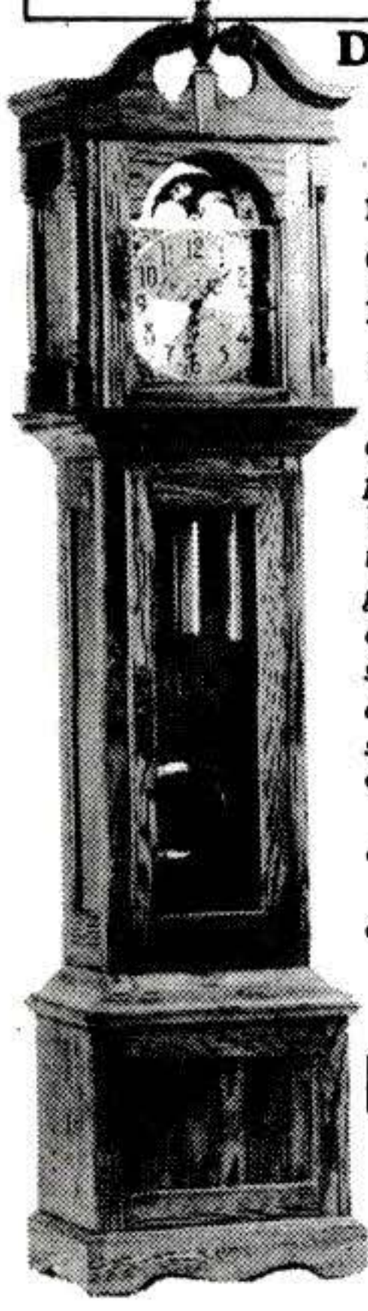

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SHOP TALK

By AL LEES

Christmas shopping at Chicago's National Hardware Show

The annual Hardware Show is scheduled in late summer to give retailers time to stock items for Christmas shoppers. Editors who tour the vast exhibit areas also get a head start on the holidays. Here are a few trends I spotted:

● Wood burners (airtight stoves, fireplace inserts, and the like) were far less prevalent than in the last couple of shows, their place usurped by kerosene heaters. I saw so many different makes—virtually all Japanese imports, including those by Kero-Sun and Corona shown in my October article—that I stopped collecting brochures after 25 or so. Companies as unalike as Bombardier and Panasonic have joined the parade, offering full lines of convection and radiant models. There was even a booth promoting a midwest testing agency's new booklet: "Consumer's Guide to Kerosene Heaters." I recommend it to any homeowner considering a purchase. Send $3.95 to PFS Consumer Information Center, 2402 Daniels St., Madison, Wis. 53704.

There were many kerosene accessories introduced, too: cans (usually yellow) to store the fuel; siphon pumps that transfer it to the heater tanks; fuel additives that promise to reduce water and odor problems; special fans to set on top of heaters (for improved distribution); safety pads to slip under them; and enclosure grilles to keep small children from touching them.

Only one other type of space heater seemed to be offering kerosene any competition this year: oil-filled electric radiators. Quartz heaters? I saw only a couple.

● Another energy appliance much in evidence at Chicago was the ceiling fan. Booths with a dozen different models spinning were commonplace, demonstrating that there's little excuse for buying an inefficient fan with so many lines to choose from—or an ugly one, although you can have a problem if your taste doesn't run to nostalgic ornateness. One company, Autumaire, offers an *outdoor* version—a sleek white beauty with three aluminum blades for installation in covered patios or screened porches and over hot tubs. The mechanism is cleverly sealed against the elements.

● The news in power tools is the trend toward expanded lines. In portables, the tune is trade up; hardware stores and home centers will be offering a broader choice in quality tools for homeowners who want to graduate from the general consumer lines. Giants like Black & Decker and Skil have started making their professional tools available through these outlets; you used to have to go to an industrial-supply house for them. You pay more, of course, but you get heftier tools designed for big, steady loads.

● The other side of this trend is the continued growth in *bench* tools—those compacts that fall between portables and the stationary tools they're scaled down from. Homeowners without full workshop space are trading up from portables to these storable stationaries that are still light enough to take to the job.

● Best new compact I saw at the show is Skil's band saw, which maintains a 10-in. throat through the full 45-deg. table tilt. I asked them at the booth to strip the case to let me see how the three wheels were mounted, and found the backbone to be a crescent of I-beam. The saw retails for around $194. Black & Decker introduced a neat little belt sander-grinder that's fine for sharpening knives and drill bits. B&D also unveiled a bench-top band saw and belt sander that are powered by any electric drill. Hirsh showed the drill-powered hobby lathe we previewed in our August "What's New in Tools," and Portalign had a drill-powered grinder.

● Omark's Credo Div. made tool-accessory news with an odd-looking circular blade baring carbide teeth—but only four of them, set into an otherwise smooth-edged disc that you can rest on the wood as you start your saw. (Larger diameters and blades for plywood have up to 10 teeth.) Called Enduro, the blade is supposed to outlast 50 steel blades, though it's priced the same.

● Skil brought more new power tools to the show than anyone else—including an $80 belt sander that automatically adjusts belt tracking to prevent drift. Skil's best portable for your gift list, though, is the dandy little cordless screwdriver you can see in this issue's "What's New in Tools." It's the first cordless tool ever priced below $40, weighs only 1½ pounds, and recharges in three hours. I only hope Skil gets it on the market for Christmas. Other notable cordless items at the show: B&D's Dustbuster-Plus hand vac; B&D's Scrub Brusher; and First Alert's Ready-Lite—the show's most innovative flashlight.

● Wall racks offering the DIY'er a full display of carded components for home plumbing and wiring continue to grow. Stanley Hardware introduced a rack of over 600 plumbing products, cleverly categorized for easy selection. Add to this trend, now, several companies offering various ducting kits. Nautilus, for one, has easy-to-install kits for both roof and

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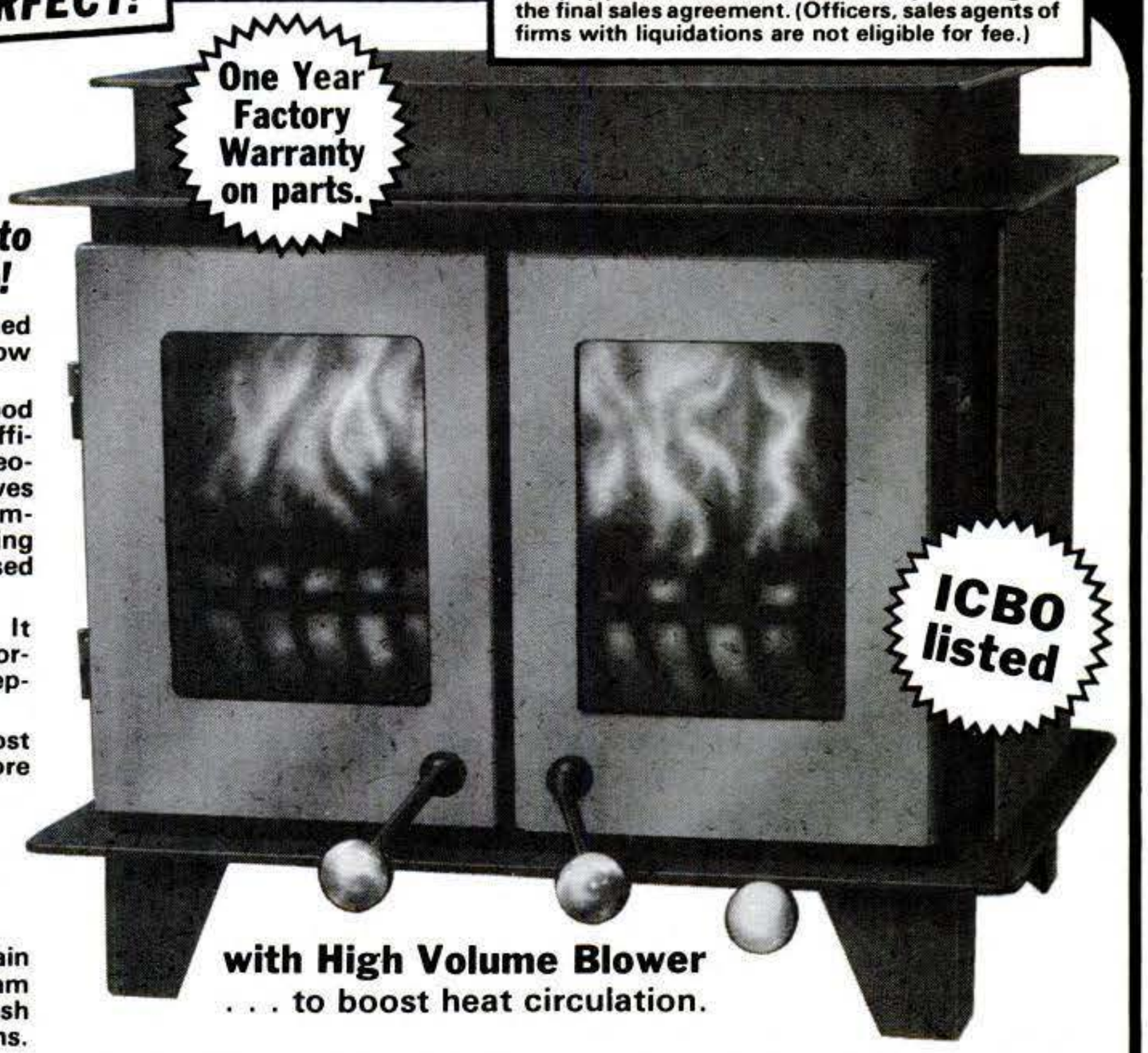
This is truly the stove of the future. Because it burns all wood (even inexpensive soft and mildly seasoned wood) more efficiently, this catalytic wood stove virtually eliminates creosote and reduces air pollution. Standard airtight wood stoves bring on a dangerous problem: black, smoky and highly flammable creosote. Now coating the chimneys of woodburning America in record amounts, creosote has already caused many dangerous chimney fires.

But this catalytic wood stove helps solve that problem! It actually burns about 90% of the black, sticky creosote normally found in wood smoke, producing extra heat and keeping your chimney amazingly clean and safe.

With the catalytic combustion system, you also burn up most of the polluting particulate emissions, giving you even more heat value. What you'll send up your chimney will be mostly carbon dioxide (what you normally exhale) and water. No other wood stove offers the kind of proven efficiency you get with a catalytic woodburning stove. In fact, the efficiencies you'll get with this stove are usually found only in the latest oil and gas furnaces.

Construction: Double wall steel body with black porcelain enameled doors and side heat shields. Heat resistant Ceram glass doors allow view of fire. Wood handles. Removable ash pan and cast iron wood grate. With complete instructions.



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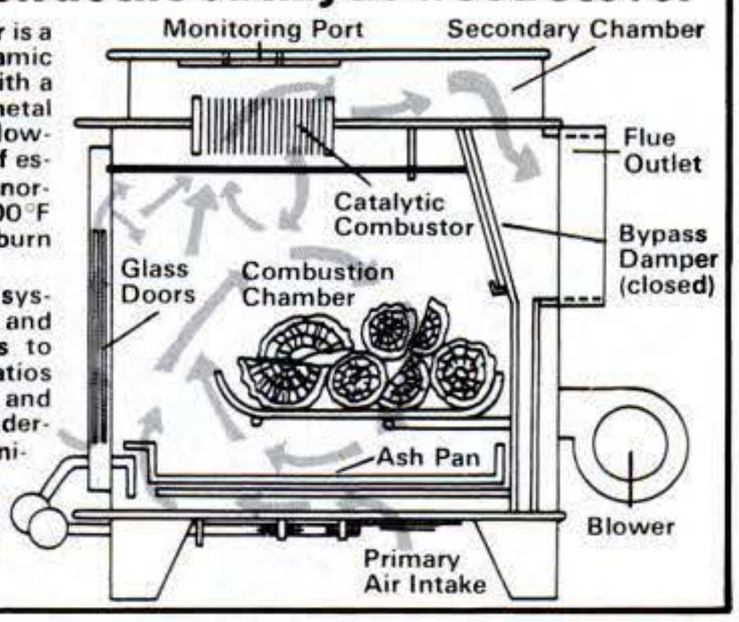
The combustion control system has both primary and secondary air controls to keep the air and fuel ratios near perfect for high and low fires. The special under-the-hearth air inlet manifold is a safety feature designed to extinguish the firebox in case the flue system becomes obstructed.



• SPECIFICATIONS •

Dimensions:	28"H x 30"W x 23½"D
Weight	448 lbs.
Flue diameter	8"
Height to bottom of flue	15⅝"
Door opening	14" x 22⅝"
Door glass size	8"W x 12"H
Door glass type	orosilicate and glass ceramic
Catalytic combustor	2600°F rated
Log size capacity	24"
Fire box size	17"D x 25¾"W
Burntime	8 to 10 hours
Heating capacity	10,000 cu. ft.
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New Pulse Meter makes your exercise safe & effective!

The Pulse Tach™ Heart Computer was developed for use in hospitals and doctors' offices by a select team of physicians and engineers. Read what it can do for you.

How fast does your heart beat when you exercise? How quickly does your pulse return to normal? Does this "recovery time" improve as you get into better shape?

Well, guess no more. The Pulse Tach Fingertip Heart Computer accurately reports your pulse to insure maximum benefit from your exercise without dangerous over-exertion.

Pulse Tach is actually a micro-computer that fits over your finger. It weighs one ounce and can be worn easily during most exercise programs. It measures, calculates and displays what your pulse is doing.

Its custom-made, powerful micro-chip circuit replaces 5600 transisitors and makes Pulse Tach the most advanced pulse instrument ever developed for consumer use.

Reading your pulse isn't as simple as it might seem. Your heart beat constantly changes —perhaps three fast beats followed by two slow ones, one fast one, four slow ones and so forth.

Pulse Tach has **two** ways to overcome the problem. First, in general or light exercise use, it "averages" your pulse every four beats. But after heavy exercise (or if you have an irregular rhythm) Pulse Tach can also compute heart-beats over a longer span of time. In fact, Pulse Tach is accurate to .4%.

AUTOMATIC, ACCURATE HEART REPORT

After Pulse Tach evaluates and processes your heartbeat, it shows your pulse rate on an extra large Liquid Crystal Display for easy reading indoors or out.

You get the clearness and consistency of digital readout without the time and bother of manually taking a pulse.

There's more. Press a button and an audio "beeper" lets you "listen" to your heatbeat. It's like having a direct line to your heart.

ALSO A CHRONOGRAPH

Pulse Tach is more than just a way to count heartbeats. It also has an independent quartz stop watch. Now you can time your exercise period, laps or anything else up to one hour.

With Pulse Tach you know when you reach the heart rate at which exercise does the most good. The stop watch feature tells you precisely how long you're at this optimum level. Then combine both functions and compute cardiac recovery time — the most important measure of cardiovascular fitness. The better your shape, the shorter your recovery time.

Pulse Tach should be used by everyone. The fitness buff knows the value of pulse monitoring and a Pulse Tach is essential for the beginner to avoid dangerous over-exertion.

Additionally, Pulse Tach will show you how your heart is affected by coffee, a cigarette or a stressful day at the office.

It makes a great gift for a wife in aerobics or your tennis partner. In fact, anyone who exercises will appreciate this little heart computer.

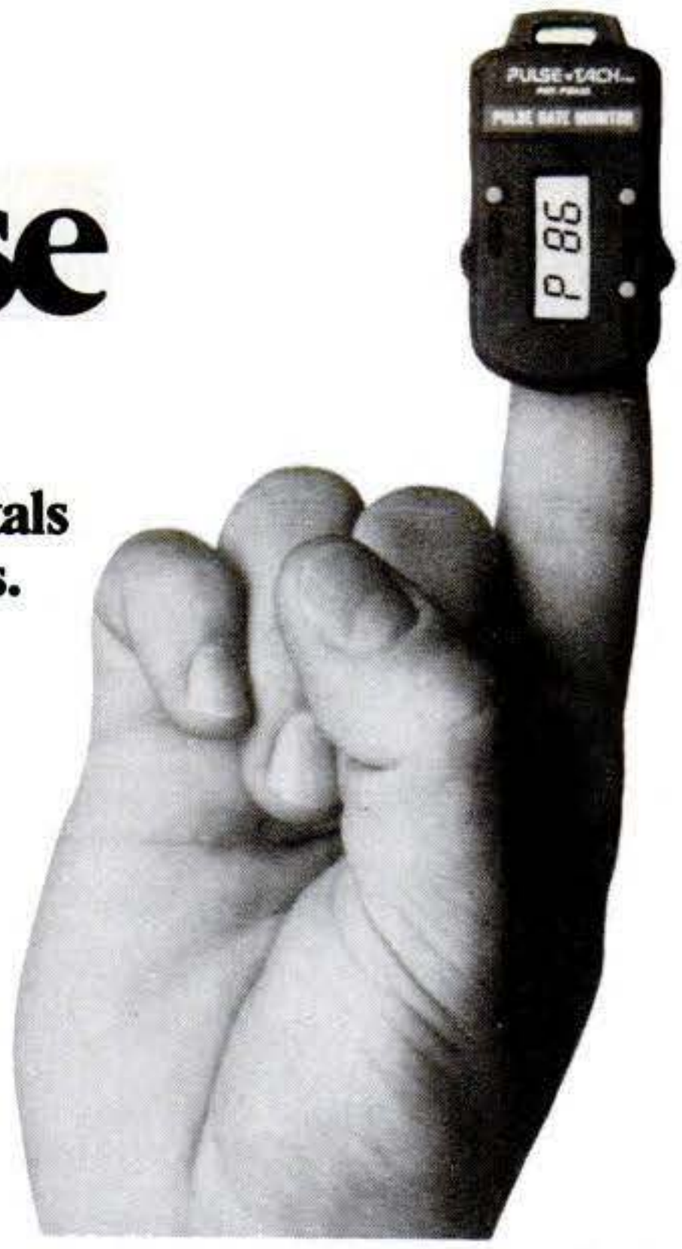
THE PRICE MAY BE THE BIGGEST NEWS

Original cost of the Pulse Tach was quite high because quantities were limited to professional use. But just as pocket calculators and computers have dropped in price when made available to consumers, so, too, it is with Pulse Tach.

The Pulse Tach Fingertip Heart Computer is only **$49.95** yet its solid-state micro-chip components give better accuracy and more features than bulky, old-fashioned pulse meters costing $100-$200.

TRY IT FOR 30 DAYS

Prove to yourself that the Pulse Tach Heart Computer is the smallest, most advanced pulse monitor on the market today. Try it for 30 days. If you're not satisfied for any reason, simply return it for a complete refund — including return postage. You're protected by a 90-day manufacturer's warranty as well as Baystar's reputation for satisfied customers.



Pulse Tach Fingertip Heart Computer is just two inches long, weighs about an ounce yet it represents a major advance in personal electronics.

Your Pulse Tach will come complete with long-life watch batteries and a necklace-size lanyard to keep Pulse Tach handy when its not on your finger. You'll also receive helpful instructions including information on your "target zone," cardiac recovery time and other exercise hints.

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To order, simply send your check for **$49.95** plus $2.45 shipping and handling to The Baystar Company at our address below. Credit card holders can speed their delivery by using our toll-free number.

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[*Continued*]

wall ducting of your home's exhaust fans.

- There were several new spray-on fire retardants—two of which compete from different sides of the river in the Twin Cities. Both Biox Fire Gard (St. Paul) and Continental Fire Safe (Minneapolis) claim that spraying curtains, upholstery—and Christmas trees—makes them nonflammable.
- There was even the inevitable "better mousetrap," this one a disposable, no-set, pre-baited box that traps the critter "humanely" (it suffocates him). If you'd like to be sure, this Christmas, that not a creature is stirring, write Contectrol, 2796 E. Miraloma Ave., Anaheim, Calif. 92806.
- Also unveiled at the show: an automatic-setback thermostat that seems far superior to anything else on the market. Installation is a simple two-wire, 10-minute affair. Called Magic-Stat, the unit's been picked up for mail-order distribution by JS&A. (In a rush to announce the item, PS got it into October's "What's New in Home Improvement" before JS&A placed a full-page ad in the same issue.) You can't lose: If the stat doesn't repay its $80 cost in fuel savings the first year, you return it for full refund.
- On any trip to Chicago, I check in at Sears Tower to find what the world's biggest retailer has cookin'. The major tool news here is that Sears has filled the gaps in its good-better-best range of stationary tools by adding at least one model saw to each line. So you now have a full choice of Craftsman table, band, and radial-arm saws. Cast-iron tables have become so costly, aluminum has replaced them on all but top-priced saws. I was shown some interesting prototypes of electronically controlled drills and routers that won't be available until July—in case you've a woodworker on your gift list who'll accept a promissory note. If not, two new cordless ⅜-in. drills are already in the Sears tool catalog—a two-speed for $70 and a variable-speed for $100. And there's a new compact 4⅛-in. jointer-planer for $185.

Energy Fair footnote

Just before the Knoxville World's Fair folded its tents on Oct. 31, I ventured back for a more thorough tour than I'd been able to take while researching my report on it for last August's issue. For the record, my only revision: A caption identified my photo of the electric-energy exhibit as an inflatable dome; on closer inspection, it proved to be a Portomod tension-membrane structure over a steel-arch framework, designed by Seaman Building Systems of Sarasota, Fla.

If you didn't attend, you may have been puzzled to see another major science magazine devote three pages of its July-August issue to bad-mouthing the fair. It should be noted that its featured photo was not even of the main grounds but rather of a remote corner of an adjacent carnival. The intent was to depict a tacky fair, but I thought the only thing demonstrated was tacky journalism. PS

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HOUSEPOWER CLINIC

By EVAN POWELL

County-wide conservation

Al Frank became director of Maryland's Howard County water-conservation program almost two years ago and, full of enthusiasm, set out to develop a residential conservation program.

His plan goes far beyond the typical mail-out-a-plastic-flow-restrictor campaign. In fact, it's almost identical to the measures I've recommended to PS readers for years: Eliminate leaks by repairing leaky faucets; replace old-fashioned leaking ball-cock valves in toilets with modern types; install water-saving shower heads and toilet dams; push water-saving habits.

Frank charted his course wisely, developing educational booklets, audio-visual materials, news releases, and even a comic book. Then he took his program to the people, starting with the big targets: town-house projects, condominiums, and rental apartments. The program cost each living unit a maximum of $20.

Al Frank's work has paid off for everyone. A report compiled after the first year shows that over 4,500 living units have been equipped for conservation. To date, the program has saved users $240,033.

Q&A Repairing refrigerator shelves

The plastic pins that hold the vegetable crisper and meat bin in our Sears Coldspot (model 106.7651460) refrigerator have broken off, and have even torn a hole in the refrigerator wall. I've tried to glue them back with no luck. Can you suggest a way to secure them and a way to repair the hole in the wall, as well?

Dennis Bradley, Clutier, Iowa

This model has a porcelain-over-steel liner, and I can't picture the support pins tearing a hole in it. I suspect that what you're referring to is actually a bow-tie-shaped hole that looks like a bad match for the pins. If so, you're in luck.

First, you'll have to order new support pins from Sears. Once they arrive, you'll see that they consist of the pin and base (the portion that you tried to glue back) plus another projection with a twisted wire in it, all molded in one piece. Insert this rear projection through the hole and twist it one-quarter turn—it will lock in place. Total cost should be less than your tube of glue.

In search of efficiency

My 17-year-old refrigerator needs extensive repairs, and I plan to replace it before summer. Referring to a previous story on high-efficiency refrigerators [PS, Dec. '74], I found the Amana unit was the most efficient at that time. How does it compare today, and is this model still being manufactured?

William Stevens, Oklahoma City, Okla.

Today there are a lot more high-efficiency refrigerators to choose from, and they're easier to compare, thanks to the FTC's energy-labeling program. Amana's "Twin System" refrigerator [PS, Aug.], a top-freezer, 18-cubic-foot-capacity refrigerator (TSC-18E), is a direct descendant of that 1975 model and is the most efficient model of its size on the market, operating for as little as $43 per year. It's especially interesting in that it borrows from the "cycle defrost" technology that preceded "frostless" refrigeration as we know it today, using a refrigerated plate to cool the fresh-food compartment rather than using colder, dry air from the freezer. According to Amana, this keeps the refrigerator compartment more humid, aiding food freshness and retarding dehydration. Since this moisture is not circulated over the freezer evaporator coils, frost buildup is significantly reduced.

Hot water from boilers

In the April issue you state that heating domestic hot water is "terribly inefficient in summer when the boiler must be kept fired just to provide hot water." I don't know what you base that on, but GAMA (Gas Appliance Manufacturers Assn.) views the subject in an entirely different light.

Robert Weik, Weil-McLain
Michigan City, Ind.

Not exactly the same subject—I was talking about old-fashioned "sidearm" heating coils in typical domestic installations, not modern tankless coils in high-efficiency compact boilers (such as your company's). The modern units have far less heat-exchanger mass and water volume than their predecessors, making off-season water heating more practical.

Burner retrofit

I have an American Standard water-heating system in my home that has worked well. But because of today's high oil prices, I had a Beckett flame-retention burner installed. Trouble is, oil consumption has remained about the same. My questions are: Should I have a coating of soot inside the boiler? (I removed it a month ago and it soon returned.) Would a smaller burner nozzle help? Do I need a ceramic coating on my stainless-steel combustion chamber? Should the install-

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er have tested smoke for CO_2 and performed other routine tests?

Jay Duckworth, Milford, N.J.

The answer to question four is a definite yes. If these tests had been made when the replacement burner was installed, I doubt that you would have had to ask the other questions. Because of their better combustion efficiency, flame-retention burners produce less soot than a conventional burner and certainly shouldn't generate enough to build up significantly within only a month. That's usually a symptom of improper air-fuel mix. This can only be set perfectly after making combustion tests, which you should have someone do as soon as possible. A good technician should also be able to tell you if your furnace would benefit from a smaller nozzle, once he interprets the combustion test results. You shouldn't need a combustion-chamber kit if yours is still in good condition. Once these adjustments are completed, your fuel-oil efficiency should improve noticeably.

Flaky oven

My five-year-old Montgomery Ward electric range has the continuous-cleaning feature, but the coating on the inside of the bottom oven is crumbling and the metal is beginning to rust. Is there a safe product that can be sprayed or painted on the surface to restore the finish? The rest of the stove is in perfect condition.

H. Carroll Pickett, Mattoon, Ill.

Most of the materials (such as porcelain-epoxy repair kits) that I've tried don't hold up to heat very well. Since this is a continuous-cleaning coating with its characteristically dull finish, you can use one of the high-temperature paints originally developed for exhaust systems on racing cars. It's available in most hardware stores. Flat black, lightened with white if necessary, would probably be your best bet to match the existing finish. Like the factory finish, it can't take much scrubbing once it's applied, so you may have to renew it from time to time.

Range interference

My Tappan gas range has an electric pilot light for the broiler that sparks, causing interference on my kitchen radio. How do I fix this?

Phillip Kennedy, St. Paul, Minn.

Many TV and electronics supply stores carry a plug-in filtering device that cleans up interference from electronic ignition systems. If that doesn't solve the problem, or if the spark seems to be occurring continuously, check the switch used in conjunction with the control knob of the gas valve to turn on the ignition. The switch may be out of adjustment or stuck closed.

Got a home-equipment problem? Write to Evan Powell/Housepower, Chestnut Mountain, Route 1, Box 322A, Travelers Rest, S.C. 29690, giving appliance make and model number. Unpublished questions cannot be answered by mail.

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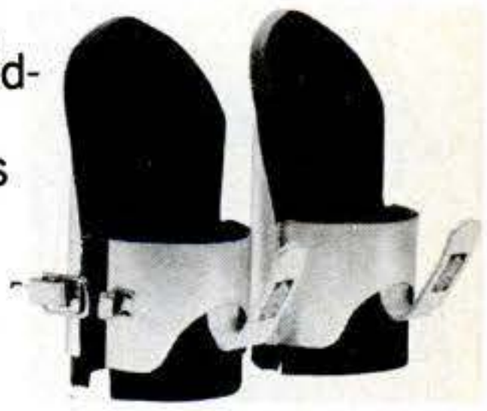

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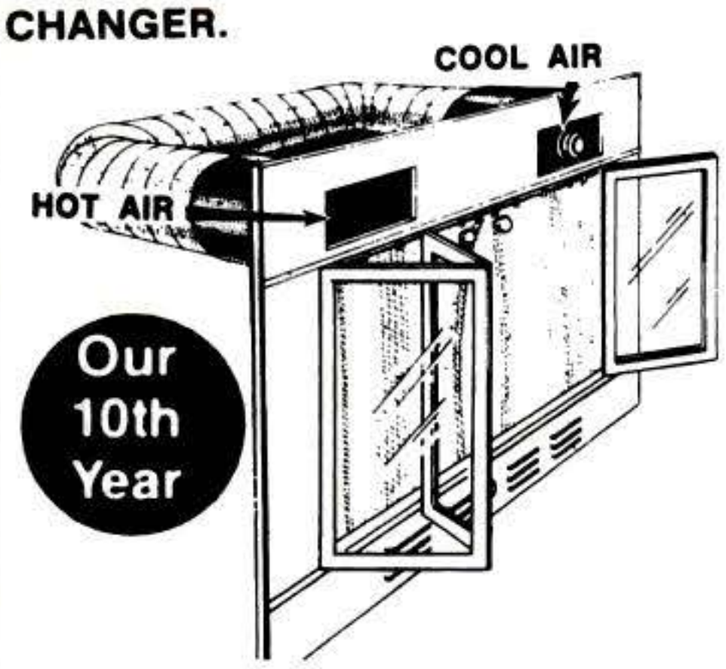

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Computer systems working?

My 1982 Cavalier wagon with power brakes and steering idles roughly, surges when I use any power accessories, and pings and vibrates when accelerating in third gear. A code 35 was identified by the self-diagnostic computer-control system, and the carburetor has been internally adjusted twice. This helped somewhat, but I still have annoying problems.

Soleyman Forouzan, Pittsburgh, Pa.

If you can find a dealer with a mechanic who understands the system, it can be fixed. The system is very complex, and no guesser is going to figure it out. The adjustments must be done with the correct equipment, and all the interrelated systems must be right. If, for example, just one pair of wires at a terminal block doesn't have good, clean connections, the whole deal is out to lunch. It's also possible that a minor engine problem can show up greatly exaggerated in this system. The truth is that the system isn't working, judging by the flood of mail I get about 1981 and '82 GM cars. If you think it's driving you crazy, you should see what it's doing to us.

TBI retrofit?

I read about throttle-body fuel injection in PS [Feb., Nov.] and wonder if it would be possible to replace the carburetor on pickups with it. At high altitude most drivers get very poor mileage from their trucks.

Norman Swanson, Idaho Falls, Idaho

Since TBI requires a costly computer, oxygen sensor, spark control, and expensive wiring, I doubt that it would be practical. I also doubt that there are units big enough for the more-powerful engines.

Hard winter shifting

Last winter it was very hard to shift the manual transmission in my 1979 Dodge D100 pickup from first to second gear until I'd driven five or 10 miles. Adjusting the transmission didn't help. How can I avoid the problem this winter?

R. Zickerman, Meadowbrook, Pa.

I suggest that you run a lighter lube in cold weather. But if you use the truck long and roughly, you'd better put the heavy lube back in hot weather.

Alignment problem

My son-in-law has a 1979 Ford Econoline 150. The tires were replaced at 22,000 miles, mainly because of front-end-alignment problems. The alignment mechanic said the only thing he could recommend for this recurring problem was to install heavier shock absorbers. Apparently, Ford has had this problem with their larger models for years and yet they keep on building them the same way. Are they really listening? My question is: Can anything be done on a permanent basis to overcome this costly weakness?

John Parkin, Santa Monica, Calif.

Check parts for being within limits and set them to spec. Pay particular attention to out-of-round wheels, and avoid very aggressive treads. The balance should stay in limits.

Lean K

My 1981 Plymouth Reliant K with 2.2-liter (134.3 cu. in.) engine hesitates and stumbles if I ease off the gas at 35 to 55 mph and then try to accelerate. It doesn't do it all the time, just enough to be annoying and dangerous. After four trips to the dealer, he says it may be the oxygen sensor and I'll "have to learn to live with it."

Roger Van Emburgh
Highland Lakes, N.J.

It's a combination of lean fuel mix and lots of spark advance. About the only help is more fuel, but then you'd have trouble with emissions. If the government would just take emissions standards back to 1980, maybe the manufacturers could catch up with the requirements. Or maybe they'll invent balloons that will tie themselves shut when they're full of residue and go off into space. It makes as much sense as what's happening now.

Cold engine kills car

What's wrong with my 1979 Olds Cutlass with a 260-cu.-in. V8? When cold, it starts hard, stalls in drive, and stalls again after restart. If the pedal is depressed fully on acceleration from stop, it just dies.

C. E. Dunnebier, Glastonbury, Conn.

It's in the choke adjustment; the choke is coming off too fast. It's not a hit-or-miss deal: The dealer must have gauges, and the carb must be set to spec.

Cold treatment for diesel

I have a 1980 Peugeot diesel, and I'm moving to Montana—a colder location at higher altitude. If heaters and other expensive changes are needed, should I consider selling my car before I move?

Bill Lewis, Socorro, N.M.

Diesels are more trouble in cold weather, but it's a big, big help to keep the engine

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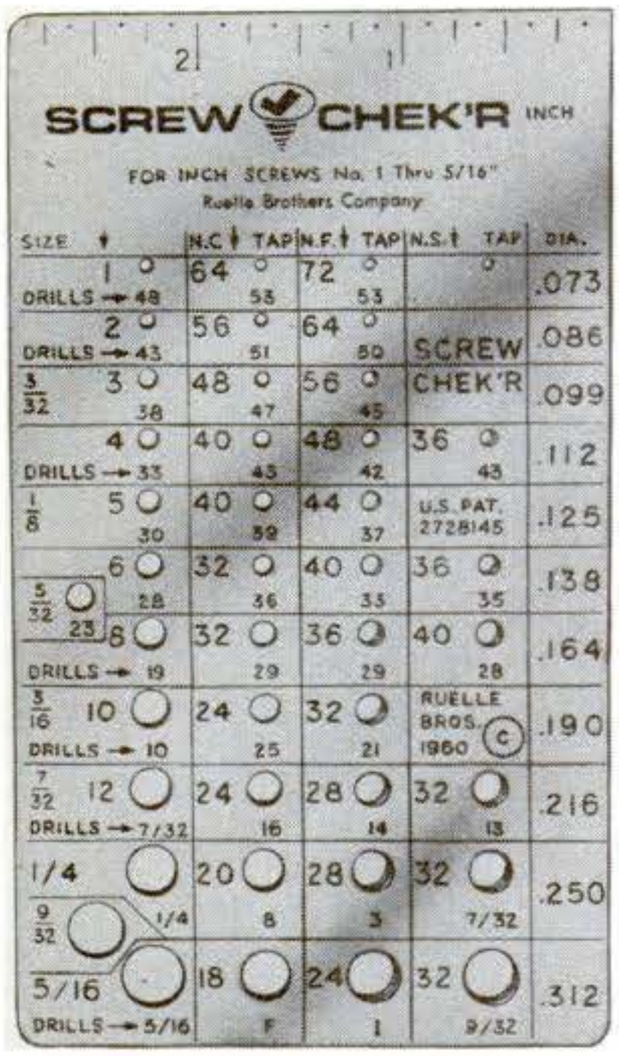

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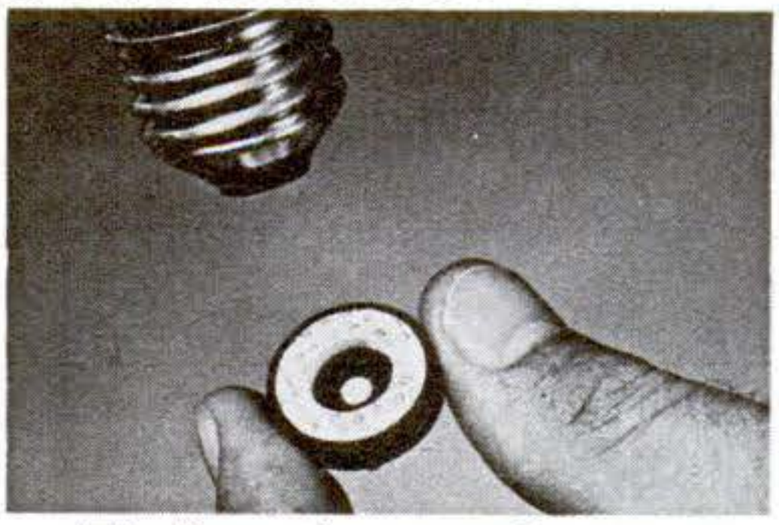

You may never change a light bulb again! Just think, no need to buy bulbs, or climb on wobbly chairs or ladders. Now, a new scientific development extends bulb life and saves electricity, too. It's called **The Button.**

The Button is a solid-state micro chip diode. It converts AC current to DC current and extends the life of a bulb filament up to 100 times!

For example, a regular bulb rated for 750 hours would last for about 32 days if burned continuously. But, with **The Button,** that same bulb's life would be extended to 75,000 hours or 8 years. Less often used bulbs could last a lifetime! (Thomas Edison's winter home in Florida uses DC lighting. The original bulbs have been burning continuously since 1925 — and are still going strong!)

This amazing development works with any regular incandescent light bulb (not 3-way type). There is even a model for candelabra size bulbs. Just stick a Button to the bottom of a bulb and screw into socket.

The results are amazing. Bulbs burn cooler, and give a softer less glaring light. You save up to 30% on electricity and just think of the money saved on light bulbs!

The Button is absolutely ideal for lights that run 24 hours a day like exit signs and security lights. (Don't replace them until 1990!) Major hotels, restaurants and corporations are already using **The Button** and saving considerably on maintenance costs.

The Button has no moving parts so there is nothing to wear out. All materials meet or exceed U.L. standards and each Button carries a 10-year warranty.

If you're sold on the idea of saving money, **The Button** comes in packages of 12 for **$29.95** (plus $2.45 shipping and handling). If you're still a bit of a skeptic (or don't have 12 bulbs), order a package of six for only **$15.95** (plus $1.50 shipping and handling). Either way, you're covered by Baystar's guarantee of satisfaction or your money back in 30 days. Be sure to specify candelabra or regular size.

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"Say, Smokey—"

[*Continued*]

and fuel warm. Adding equipment can introduce downstream problems, but a little thought and a good diesel man should prevent them. Should you sell your diesel? Take it to the bottom line—should you ever have bought it?

Pressure dilemma

When my tire dealer installed snow tires on my 1981 Honda Accord, he inflated all four tires to 32 psi and told me that would provide the best traction and service life. But the Honda manual recommends 24 psi for optimal comfort and stability.

H. S. Skovronek, Morris Plains, N.J.

For maximum traction, use lower pressure; for maximum tire life, higher is better (not exceeding the maker's maximum recommended pressure). Optimal tire traction includes consideration of weight. Use less pressure with less weight.

Aid for hot-start problem

Your solution to R. Jonak's hard-starting problem [PS, May] leaves a bit to be desired. A common fix for the Chevy hot-start problem here in the warm Southwest is to add an extra solenoid with a heavier wire connected directly to the battery. As assembled, the red wire from the ignition switch is too long, too small, and misrouted, so there's not enough voltage to energize the solenoid. If the added solenoid is located near where the wires exit the fire wall, the length of the wire from switch to solenoid can be reduced by as much as 80 percent.

C. L. S., El Paso, Tex.

Thank you. I agree that your suggestion will cure some hard starters with heat problems—but not all.

Oil frying in the pan?

I have an air-cooled VW. The previous owner installed an oil-temperature gauge. At what temperature is the engine overheating and does the oil stop lubricating? Does the rating of oil matter?

Jon S. Greene, Los Angeles, Calif.

The best mineral oil is a dead player at 300 deg. F, and if the oil temperature in the bottom of the pan reads 280 deg., the bearings are probably seeing 300 to 310 deg. Viscosity doesn't necessarily indicate temperature capabilities, but a light oil—SAE 10, say—is likely to get noisy and cause damage at 280 deg. in the pan. With SAE 40 you might get a little farther down the road, but you'd end up the same.

Each month, Smokey Yunick answers questions on cars—family cars, high-performance models, and racing vehicles. Got a problem? Send it to: "Say, Smokey—", POPULAR SCIENCE, 380 Madison Ave., New York, N.Y. 10017. All letters are read, and those of widest interest are answered in this column. Due to the large volume of mail, Smokey cannot reply to letters that are not selected for publication.

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YOUR PRESENT STORM WINDOWS ARE NOT ENOUGH!!!

The *Torlite II* system can double or triple insulate 10 average size windows.

SAVE MONEY ON HEATING COSTS

One ***Torlite*** kit can cover over 160 square feet of window area. This means you can stop **heat LOSS** and PREVENT cold air infiltration from **ten average size home windows**. With an energy savings that may equal **ten times** the cost of one kit.

The ***Torlite*** window system has been used exclusively by industry both here and abroad for many years. Now **limited supplies** are available for public and private use. The ***Torlite*** window system installs in **five minutes**, using no nailing strips, screws or tools. ***Torlite*** is a totally new **100% optically clear** and tough film with no **cloudiness** or **haze**.

Even should you have storm windows, you can form another insulation barrier against **heat LOSS** and SEAL OUT **cold air infiltration**. The ***Torlite*** window system creates an **insulating pocket of air** inside your window area by keeping cold air OUT and keeping IN your heated room atmosphere.

Any type window, be it casement, bow, jalousie, steel, aluminum, wood can be made 100% air tight. Trailers, factories, farms, apartment buildings, churches, hospitals, schools, motels and virtually every business can use this system to **realize substantial energy savings.**

No other window kit available on the market today offers the amount of window coverage and **energy savings** of the ***Torlite*** **system**.

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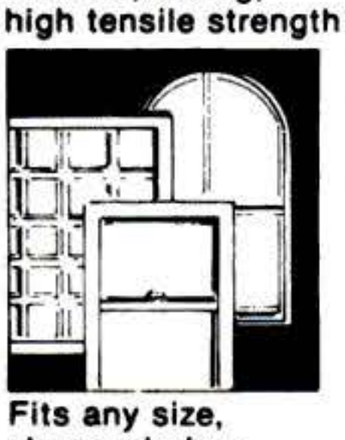
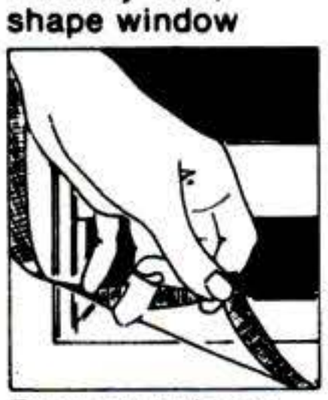


Fits any size, shape window



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- The sun's ultraviolet rays have a minimal effect on the ***Torlite*** film.
- The ***Torlite*** comes packaged on a roll, not folded or creased, so you are assured of receiving a quality product.
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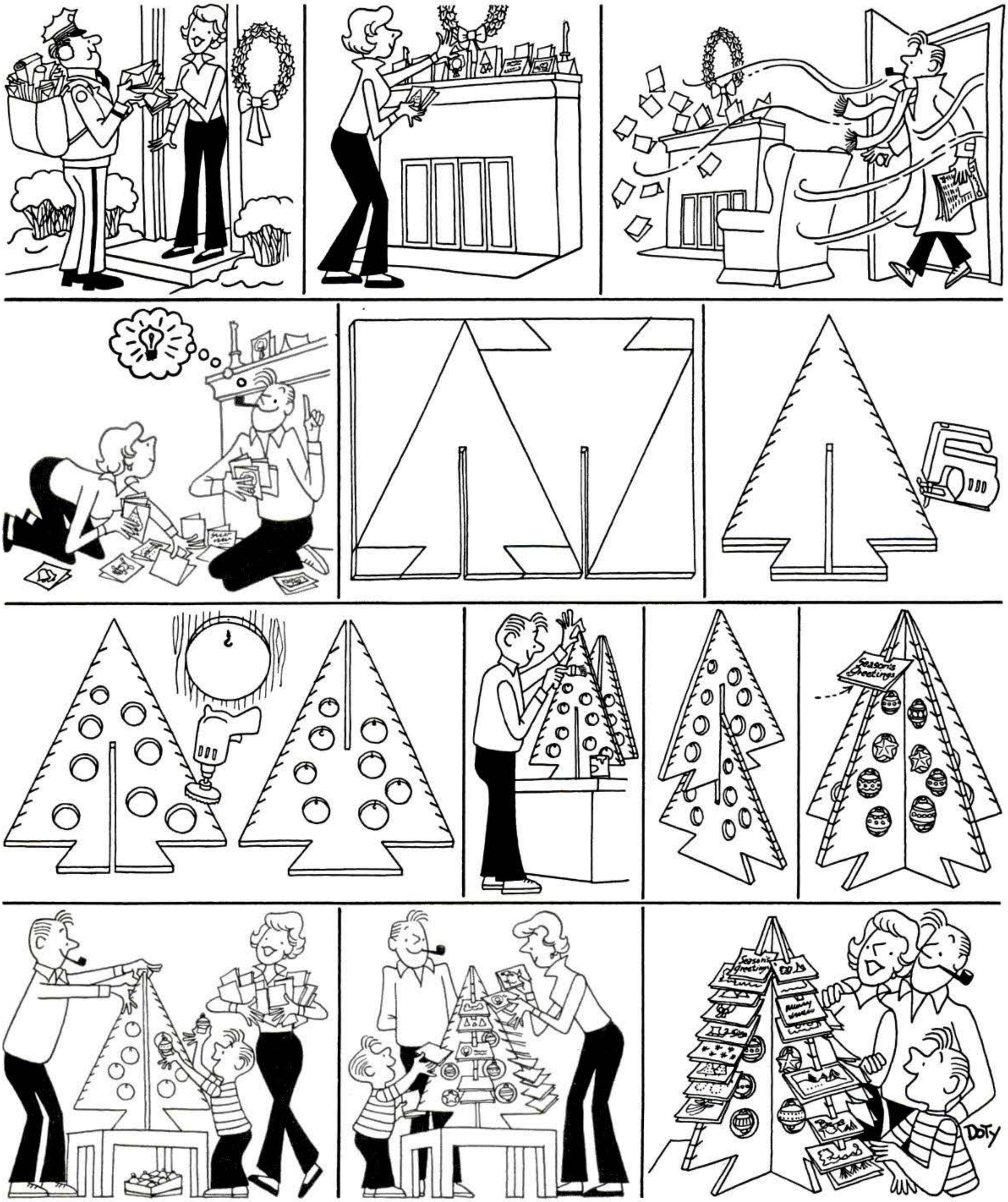
WORDLESS WORKSHOP

By ROY DOTY

Thanks and $50 to Andrew Lucchesi of Great River, N.Y., for the idea from which this was adapted. Send your idea (with Social Security no.) to Wordless, Popular Science, 380 Madison Ave., New York, N.Y. 10017. Only purchased ideas can be acknowledged.



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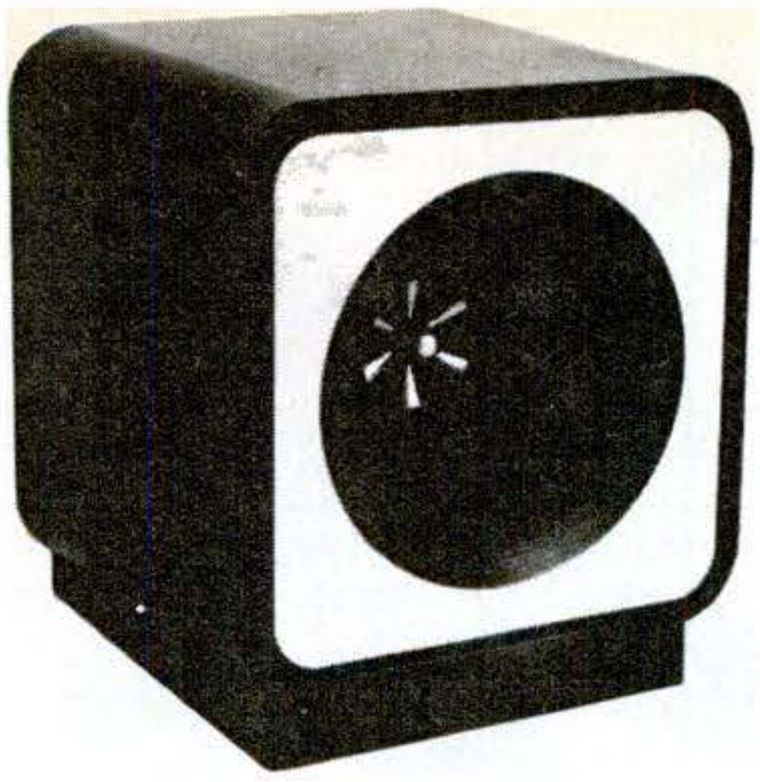

PEST-PRUFE™ is small and unobtrusive--rugged, hi-impact case has black finish with brushed silver face. Measures only 3-1/2"x 4"x 3-1/2". Weighs about a pound.

Clear Your Home of Mice, Rats, Roaches and Other Pests--and Keep Them Out!

PEST-PRUFE™ is a home-size version of the commercial pest control device that's safe for people, pets and the ecology. Try it in your home for 30 days.

They don't call them pests for nothing. The bugs and rodents of this world can make life miserable. Traps, sprays and poisons seem to have little effect . . . and professional exterminators don't come cheap. But now you can eliminate troublesome pests and keep them out thanks to new utltrasonic PEST-PRUFE.

The electronic PEST-PRUFE unit doesn't kill rodents or insects—it repels them. Early laboratory research showed that ultrasound was effective in modifying the behavior of mice and rats.

As commercial exterminators began using ultrasonic sound to control rodents, other studies indicated that certain frequencies affected the behavior of insects, too. Now, professional pest control companies acknowledge the usefulness of ultrasonics in controlling certain rodents and insects.

UNIVERSITY TESTED

The heart of this new, electronic marvel is a special quartz crystal speaker. It enables PEST-PRUFE to emit ultrasonic sounds that only pests can hear.

These ultrasonic frequencies "attack" the auditory and nervous systems of rodents and certain insects causing pain and discomfort. The pests are forced to abandon the covered area and will not return while you continue to use PEST-PRUFE.

A leading university tested PEST-PRUFE as absolutely safe for humans and pets. And since there are no poisonous chemicals, the ecology is not harmed in the slightest.

The ultrasonic output is above the hearing range of humans and household pets, so PEST-PRUFE is safe for use anywhere. It will not interfere with any electronic burglar alarms, fire or smoke detector, TV reception or other electronic equipment.

SET UP A BARRIER TO KEEP PESTS OUT THIS WINTER.

When you get your PEST-PRUFE you'll begin to notice some results in a few days. In two to six weeks your infestation will be eliminated. Then continual operation of your unit will prevent further nesting and inhabitations.

Even with colder weather approaching, you can keep pests from coming indoors as long as your PEST-PRUFE is in operation.

JUST PLUG IT IN.

There's no installation with PEST-PRUFE. All you do is plug it into any 110-Volt AC outlet. The solid-state electronics and quartz crystal speaker require only 5 watts of power—just pennies per month—and it's maintenance free.

Put PEST-PRUFE anywhere: home, apartment, store, warehouse, or factory. It's the perfect answer for facilities where food is stored or handled such as schools, hospitals, and nursing homes.

It will repel pests from areas that are difficult to seal-off such as garages, farm outbuildings, boats and vacation homes. One unit protects an area up to 2500 cubic feet.

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PEST-PRUFE is state-of-the-art technology. Until now, commercial units used by professional pest control companies cost up to $200—but lower cost solid-state components allow PEST-PRUFE to give you the same pest repelling power for only $49.95 (plus $2.85 shipping and handling). Now there's no need to empty messy traps or buy poisonous chemicals again and again.

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We urge you to try the PEST-PRUFE unit for 30 days. If you don't see proof that it is the most advanced, efficient pest eliminator available today, return it for a complete, no-quibble refund—including return postage. You are protected by a one-year manufacturer's warranty as well as Shelburne's 26-year reputation for satisfied customers.

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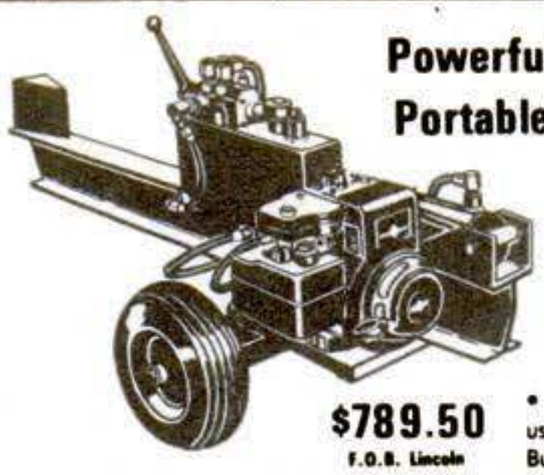

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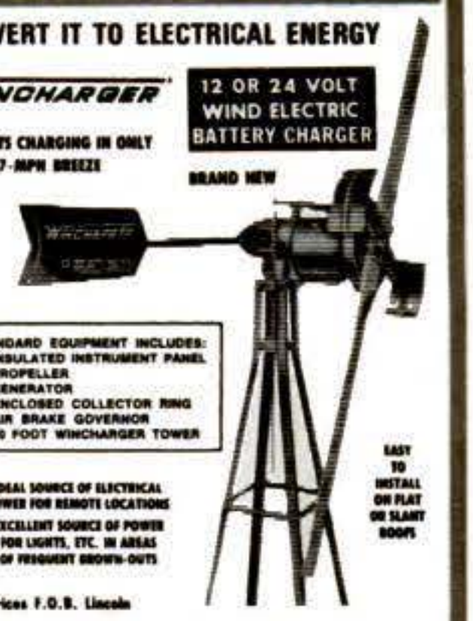

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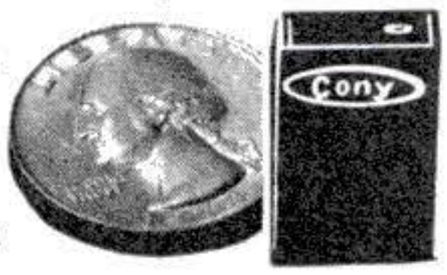
The Dyna-Mike Transmitter

It's smaller than a quarter. But DYNA-MIKE will transmit every sound in a room to an FM radio tuned to the proper unused frequency, from ⅓ mile to 2 miles away.



If you're at a neighbor's home a block from your own, you can hear your baby's cry, or you can tell the instant your spouse comes home. If two of you are driving tandem in two cars, one or both of you can communicate with the other even if other cars drive between you.

DYNA-MIKE has as many uses as your imagination can think of. For a business conference, let the tiny microphone sit unobtrusively on the table or concealed on a shelf, and you'll be able to record every word. For businesses, you can put an FM receiver in a warehouse or remote office and "broadcast" instructions or orders to be filled.

Public speakers never had a better friend than the DYNA-MIKE. No wires or setup — just turn on one or more radios and your speech will come through with perfect fidelity. Put one on the front porch. If you hear a suspicious sound, turn on the radio and you'll hear the doorbell or the ring of the telephone.

Choose Your Model

New Horizons is introducing three models of the DYNA-MIKE supersensitive broadcast microphone. Model IC-18 is the world's smallest micorphone — it's a miracle of electronic miniature power, with a high-fidelity range of 1800 feet. Introductory price is $129.95 (two for only $119.95 each).

Model X-18 is the longest-range microphone, with an unbelievable two-mile range. Introductory price is $149.95 (two for only $139.95 each).

Model X-3 is the most sensitive microphone. It broadcasts perfect-quality sound even from low-levels or whispers, up to 1,500 feet. Introductory price is $99.95 (two for only $89.95 each).

Each microphone is fully wired, complete with standard HC-1.35v. battery, good for 100 hours of continuous use and easily and inexpensively replaceable.

Of course you're protected by the New Horizon guarantee: use any DYNA-MIKE transmitter microphone for 30 days, with the right to return it for a full refund if you're not delighted.

— Phone or use this coupon —

The Super-Ear

You'll hear it all.

Effortlessly, you can hear not just a baby's cries, but quiet breathing, through a concrete wall a foot thick. Put the SUPER-EAR earphone in your ear and place the speaker on the wall. That's all there is to it.

SUPER-EAR hears everything, and even more astounding, hears it clearly. It's as though the wall weren't there. If you're coming home late at night and think intruders are in your residence, let SUPER-EAR find out for you. Want to know if the meeting is over in the room with the closed door? SUPER-EAR will tell you in a second.

SUPER-EAR is undetectable from the other side of the wall. The quality of sound has amazing fidelity—good enough to record, and SUPER-EAR has its own built-in recorder jack.

Because SUPER-EAR is the ultimate listening device, you can use it to pinpoint hidden squeaks in your car or the source of mysterious engine noises. Construction experts use it to check for flaws or cracks in buildings.

It Works Anywhere!

Ever put your ear to a railroad track to try to hear the train? Try it with SUPER-EAR. You'll hear that train many miles away. Use it as a powerful stethoscope on yourself, a friend, or a pet. You can even hear a bird's breathing.

The only source for SUPER-EAR is New Horizons. Choose from two models — Model SB-5, with ultrasensitive microphone, $139.95 (two for only $129.95 each); or Model SB-1, with suction-type microphone, $99.95 (two for only $89.95 each).

Use your SUPER-EAR for 30 days. If for any reason you're not delighted, the absolute New Horizons guarantee means you can return it for a prompt refund.

The Phone Answerer Recorder

The PHONE ANSWERER/RECORDER connects in seconds between any tape recorder and your telephone. When you're away it automatically delivers a message up to 20 seconds to anyone who calls: when you'll return, when to call back, where you are.

When you're there, the ANSWERER/-RECORDER starts any cassette recorder automatically when you pick up the phone and shuts off when you hang up.

It records both sides of the conversation with astonishing clarity, giving you a permanent record of every call, preventing unauthorized use of your phone, and eliminating misunderstandings over what was said. It's specially wired to extend recording time on your tape recorder. Needs no batteries - it's always "alive".

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- ☐ 2 for $139.95 each
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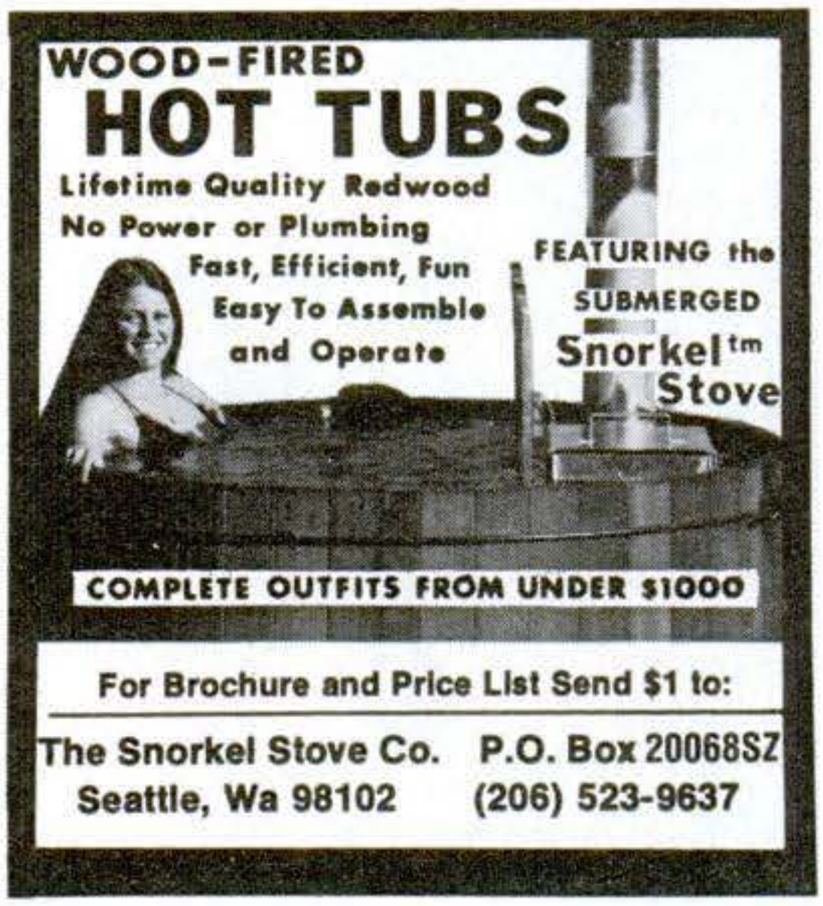

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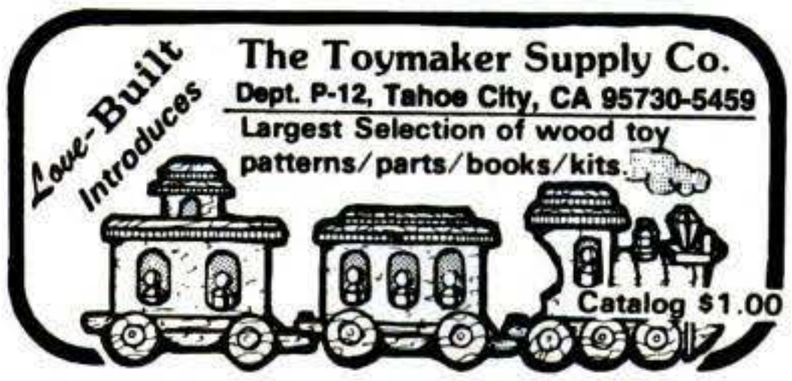

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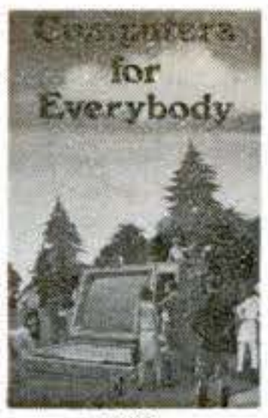
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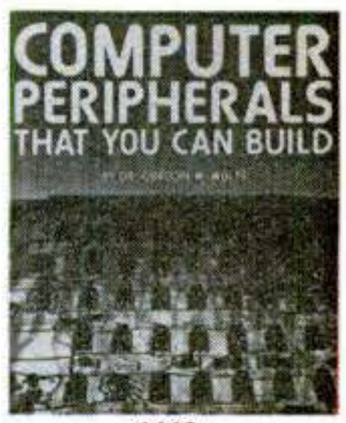
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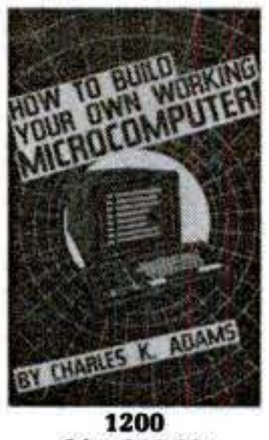
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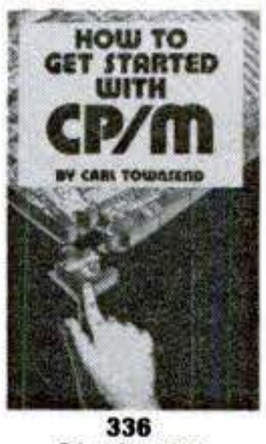
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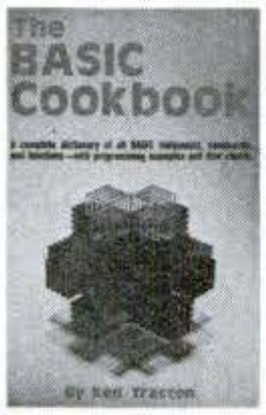
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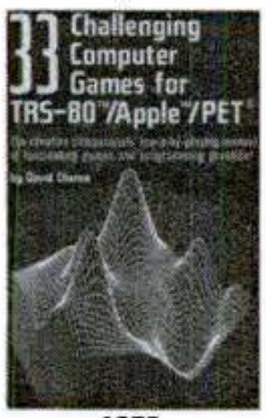
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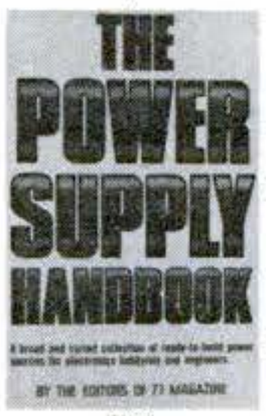
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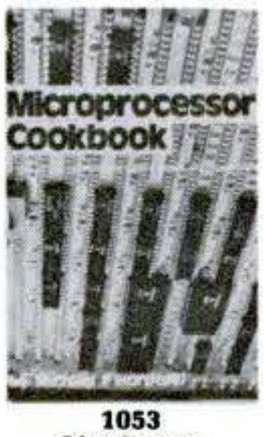
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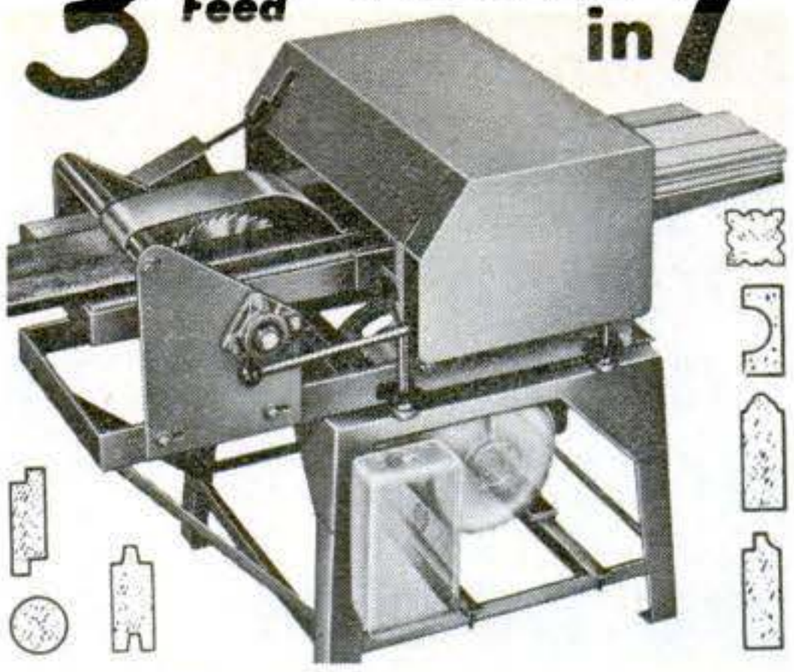

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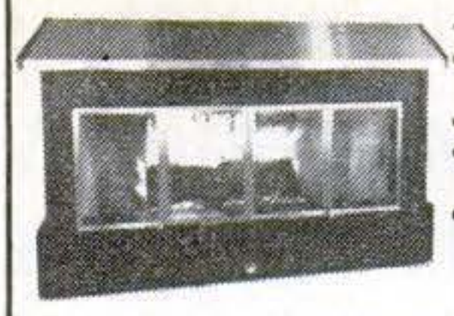

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PRICELESS INVESTMENT

I was introduced to your Monster Maul... Not only did it save me a great deal of time, but it also saved me the expense of buying other mauls—as I would go thru 3 or 4 in the span of less than a year. In fact, the foreman of the City of Medford's Forestry Dept. referred to the Maul as "a priceless piece of equipment." The maul is one of my best investments...

R. DiGiacomo, Medford, Mass.

MONSTER MAKES HIM A BELIEVER!

Quite frankly, I ordered the "Monster Maul" because of your no risk money back guarantee. I figured I would try it and if it didn't work out I would return it and the real loss would be yours, not mine. Well, you won't be getting it back. You made a believer out of me. . .the Monster Maul does get the job done and for the money, it's the best bargain around. Thanks for a darn good product at a price that is "easy" to live with.

John Geras, Bolingbrook, Ill.

DYNAMITE!

I have used your Monster Maul for two years with outstanding results. I know of nothing that can compete with this device in curly or difficult wood-except possibly dynamite! Wood cutting would be much more burdensome if I weren't able to split the big stuff in the woods so I can get it out much easier. This is a real wood splitting machine. I think I could out-split a mechanical splitter especially if the wood was curly or knotty. I see you now have a lady maul for splitting clear wood and small stuff. . . So we are going to order one. I feel if I can't split it, I'll bash it into kindling!

Jackie E. Allen, Warsaw, Oh.

WHAT'S YOUR HANDLE?

Have received your Monster Maul that I ordered 2 weeks ago. It is everything you claimed it is. I had to try it as soon as I got it...had some large knotty apple and some other hard splitting wood. Your maul made short work of it. Also gave the Sotz news to a friend who lives up the road from me. He likes the maul I got from you also. I split some oak with it that his maul wouldn't even dent. He liked the pipe handle, his has had 3 wooden handles so far.

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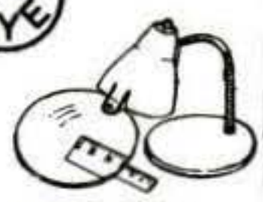

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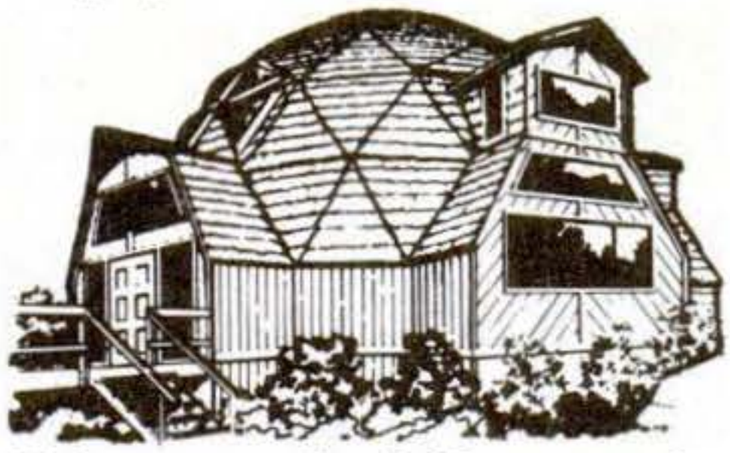

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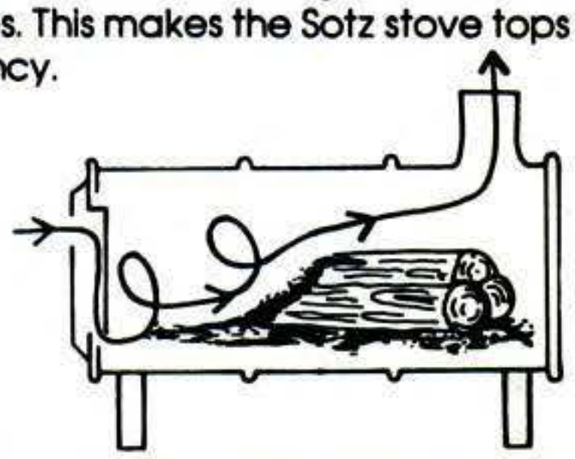

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P. Mathewson, Willimantic, Ct.

SURPRISED FIREMAN

I'm using one of your fireplace kits. To my surprise, the stove heats my whole house (even down the bedroom hall). As a full time fire fighter I can say that the stove is completely safe as your instructions say.

Robert Dunkel, Worthinton, Oh.

WHO NEEDS IT?

I am heating a 25' by 25', 3 story farm house with one of your double barrel stoves in the basement. I put it in in Jan. last year and left the oil furnace running (the woodstove was put in to help only). After two weeks I decided the oil furnace only ran to maintain boiler heat so I shut it down. Fantastic, I couldn't believe it. +6°, 30-35 mile per hr. winds., 75° in dining room, living room and kitchen. I am well satisfied with this.

L.D. Hubbard, Upper Marlboro, Md.

NO BARREL OF PICKLES

I have a three year old double barrel stove and couldn't be more pleased. It's just as good as the day I built it. There was an Earth Stove in our house when we moved here and my barrels out perform it 100%. As far as I'm concerned there isn't a more practical, useful, or easier-to-operate stove in the world. If more American manufacturers delivered on their claims for their products the way Sotz does, our country wouldn't be in the pickle it's in now.

L.E. Peterson, Connersville, Ind.

MONSTER BEATS MACHINES

Last summer I ordered a Monster Maul. It does such a terrific job. I would like one for my nephew. I have a screw splitter and also a hydraulic splitter, this Monster Maul beats both of them. Only this week I was visiting my sister... She had a big pile of stringey oak, that had been cut about 4 weeks. I put my cone splitter on, thinking it would do the job. I found out the only good job was done by my M-12... maul.

A. Chandler, Lancaster, Ca.

FIRE BELOW

I am most pleased with your barrel stove. Many of my friends were amazed. It really does hold a fire for 24 hours at 40 below zero. I only stoked the furnace twice a day.

J.J. Oravetz, Montello, Wis.

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We are elated with your barrel kit. There is no comparison to the traditional wood burners on the market today. The two barrel stove will extract more heat from wood than any other burner we know. Besides saving in hours of labor. The 12" door opening plus 30"-36" long length saves time and labor in the preparation of the wood for the burner. My son recently installed one in his huge house which always had a heating problem and a tremendous fuel oil bill and today their savings amounts into a few hundred dollars each year.

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R. Greiner, Greenville, N.Y.

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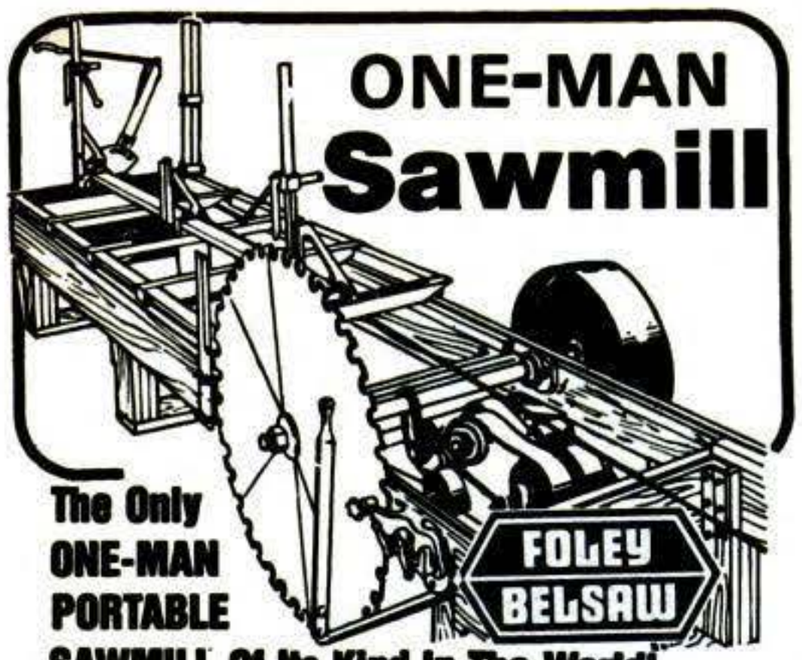

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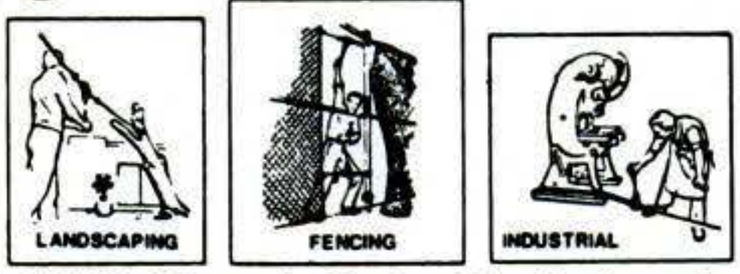

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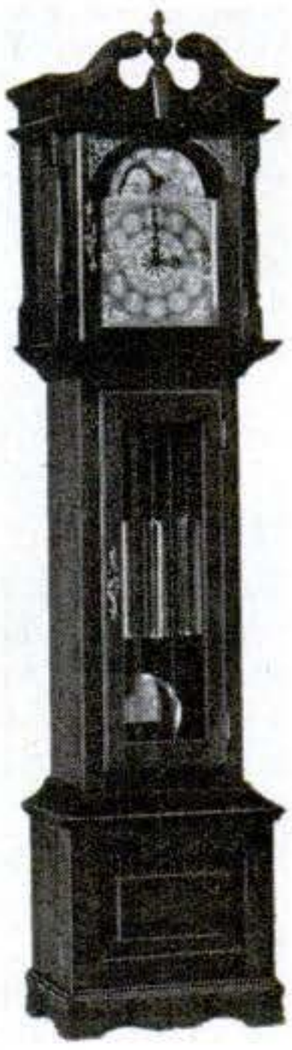

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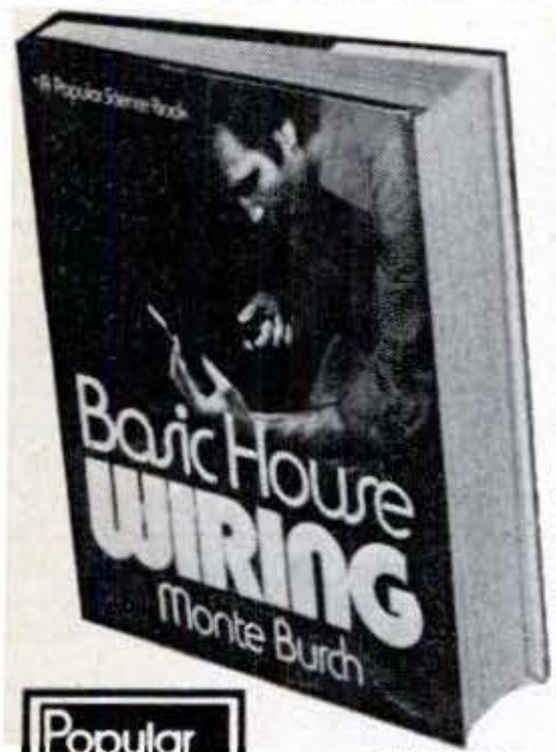

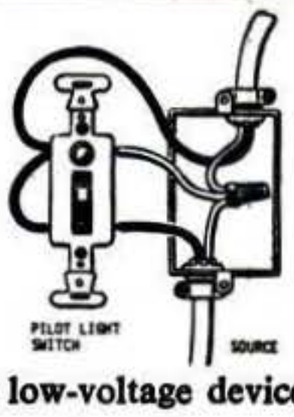

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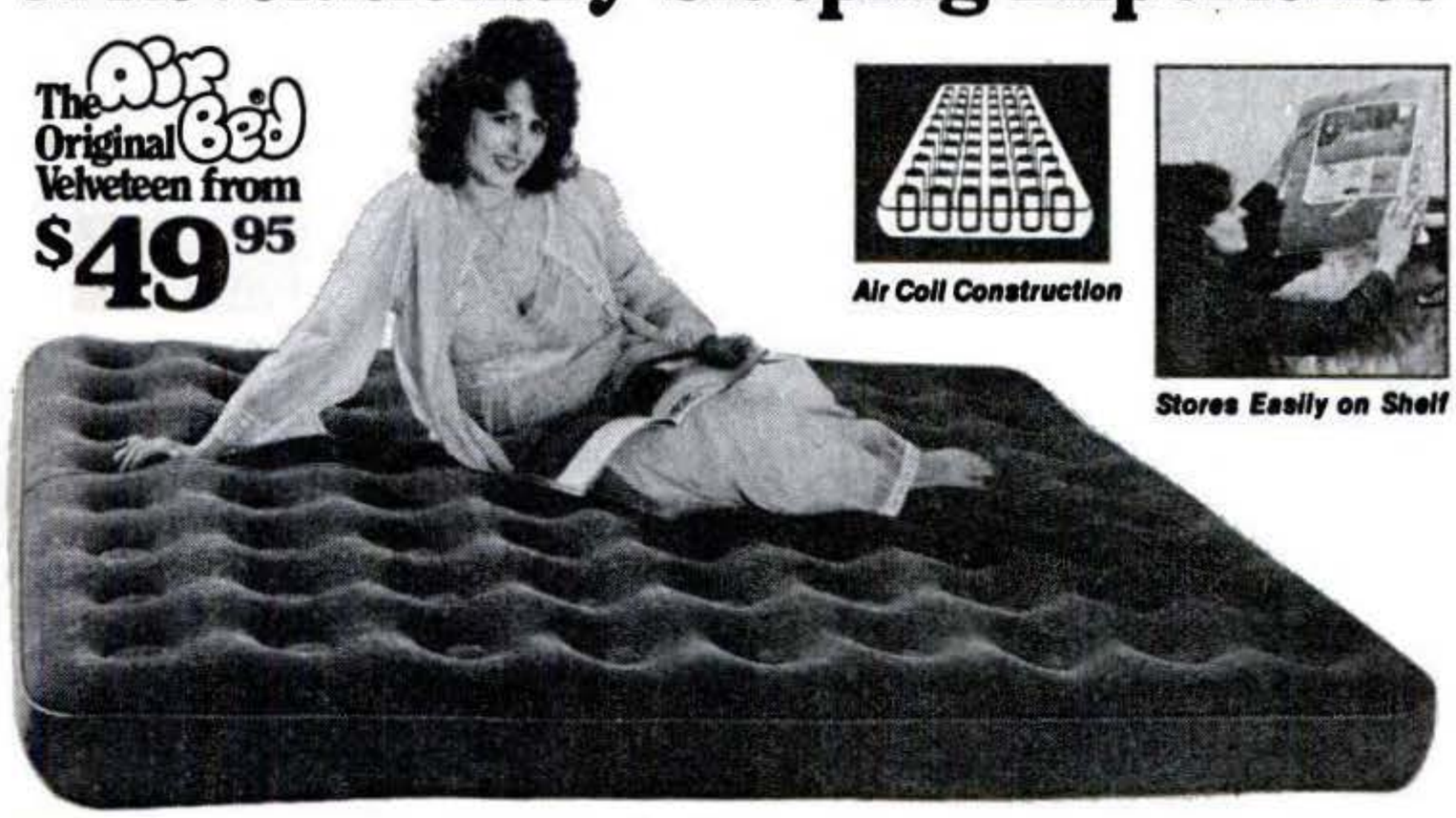

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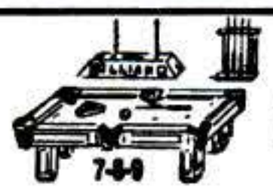

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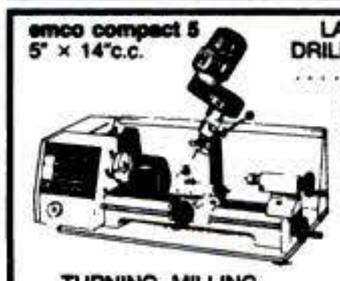

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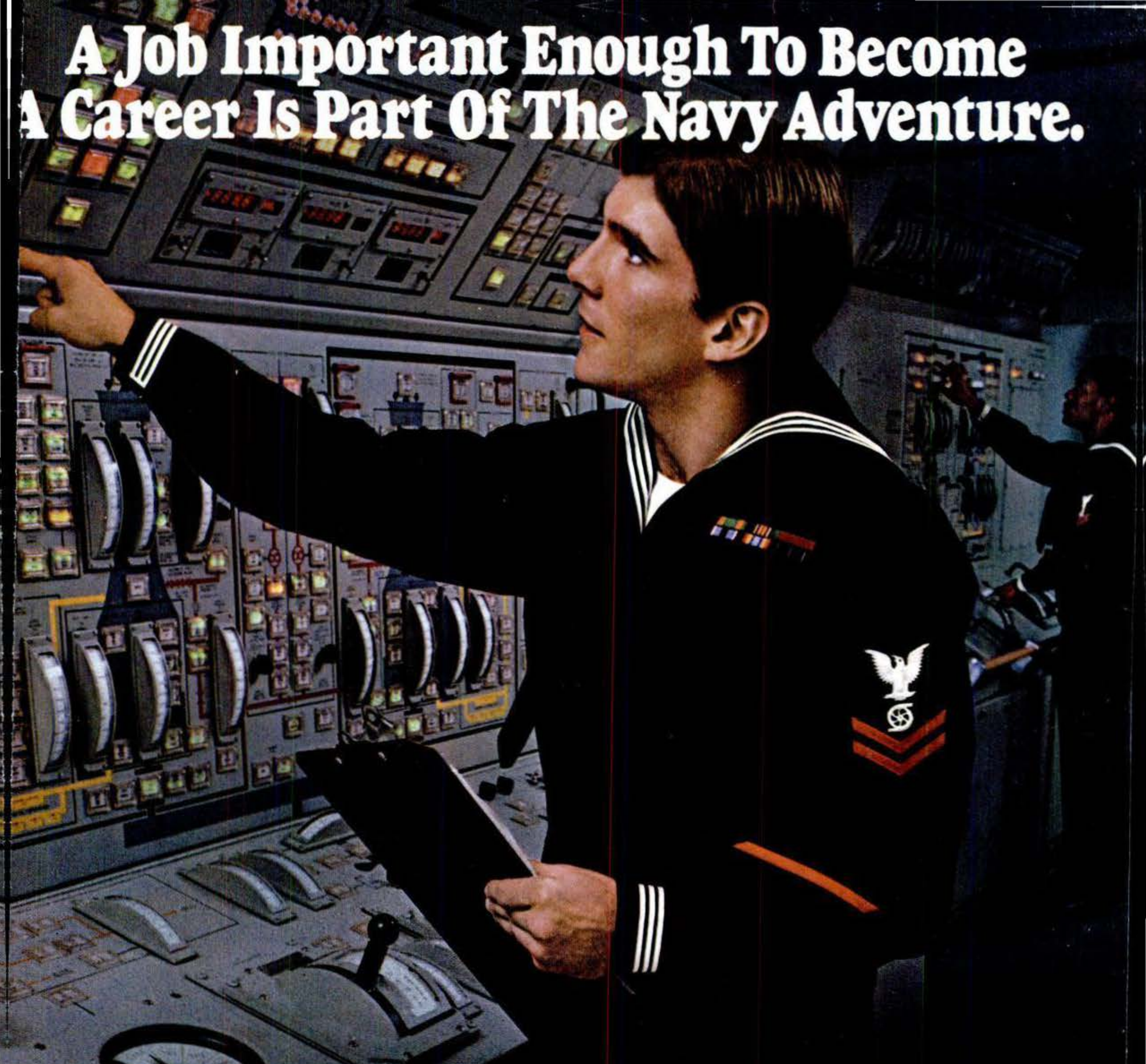

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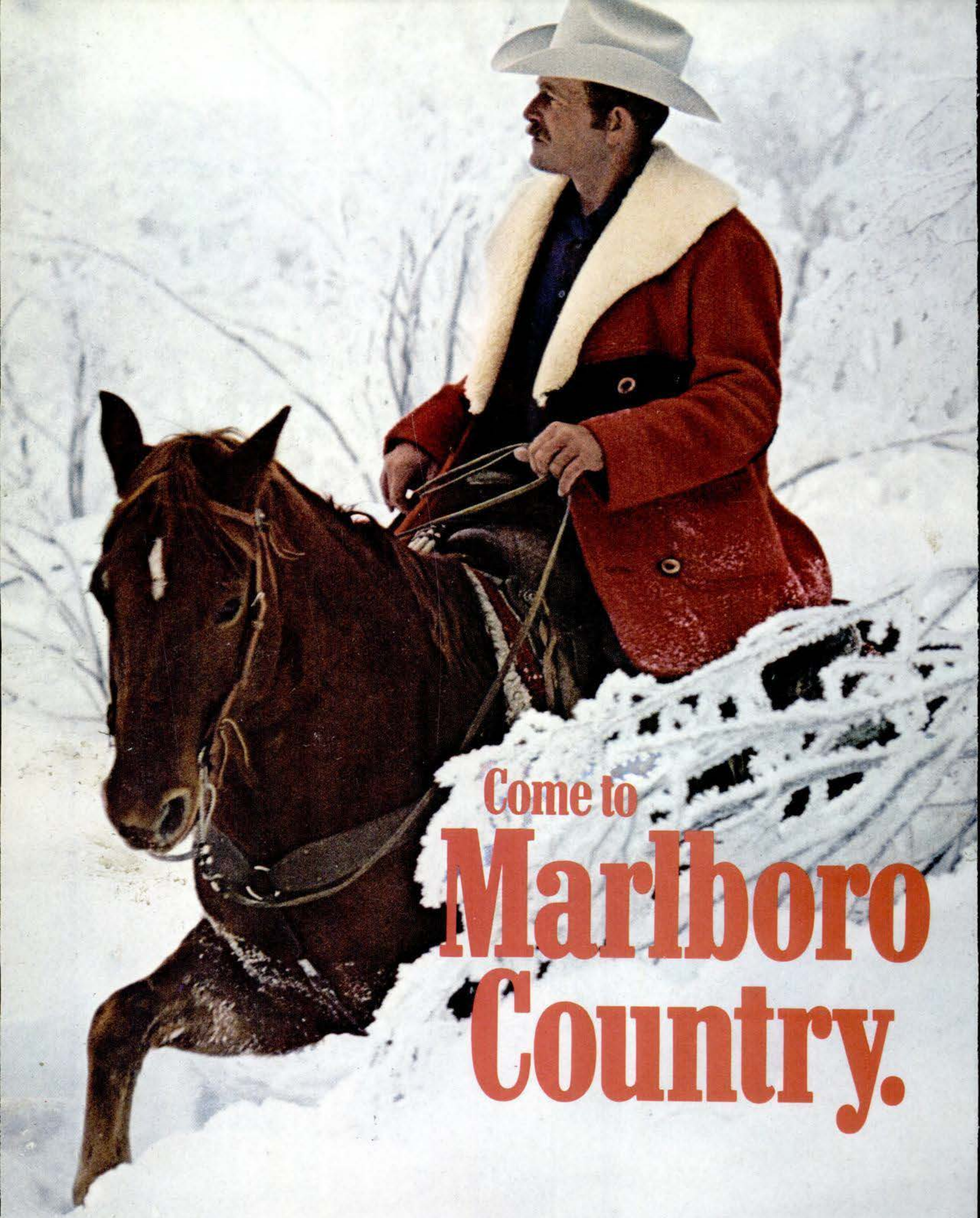

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